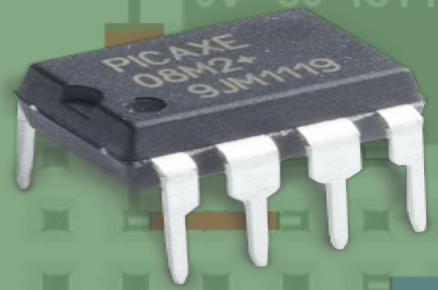
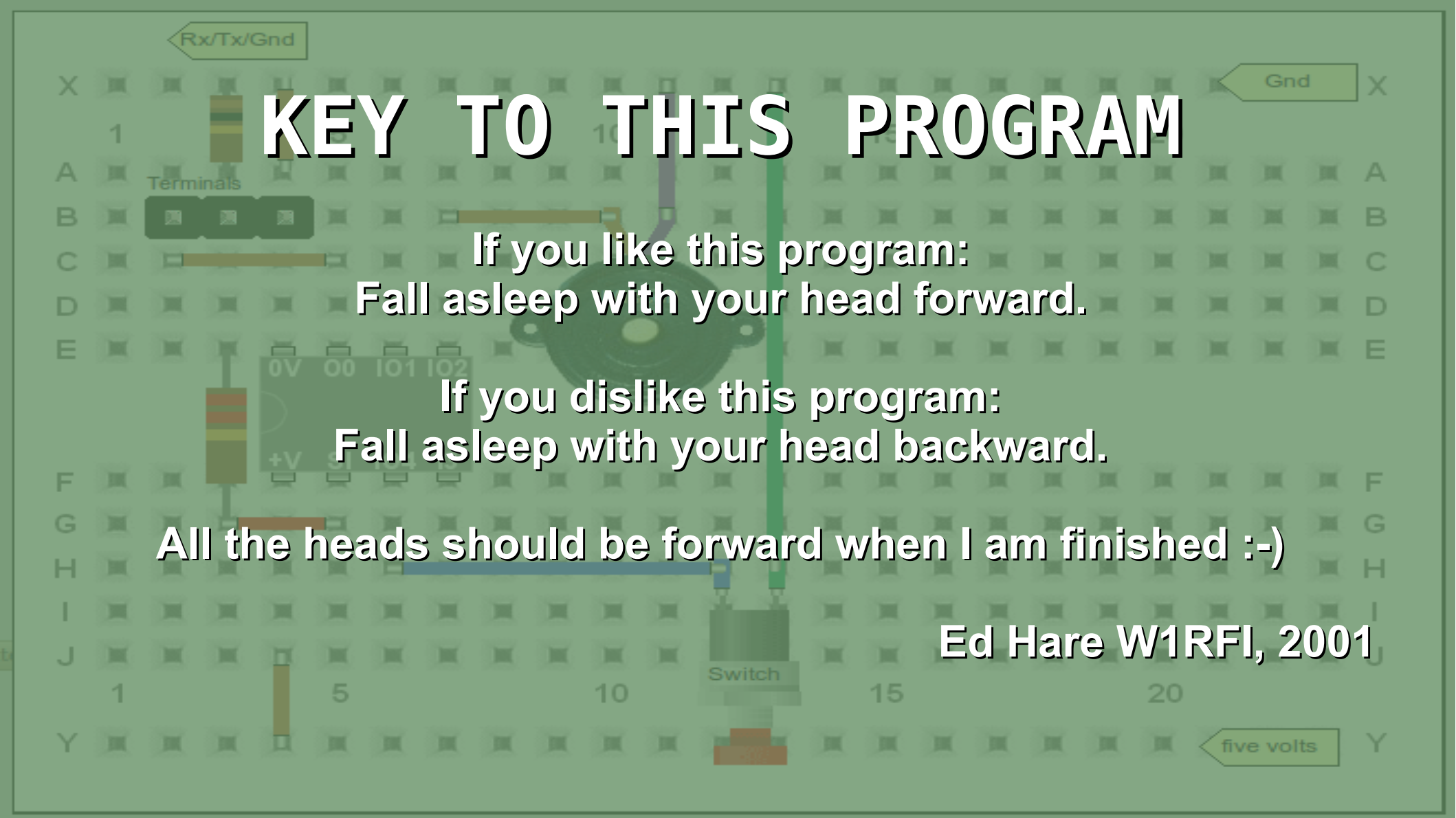
BASIC MICROCONTROLLER INTERFACE TECHNIQUES



Darrell Davis KT4WX
ARRL Technical Specialist
ARRL West Central Florida Section

2022 ARRL / TAPR Digital Communications Conference.



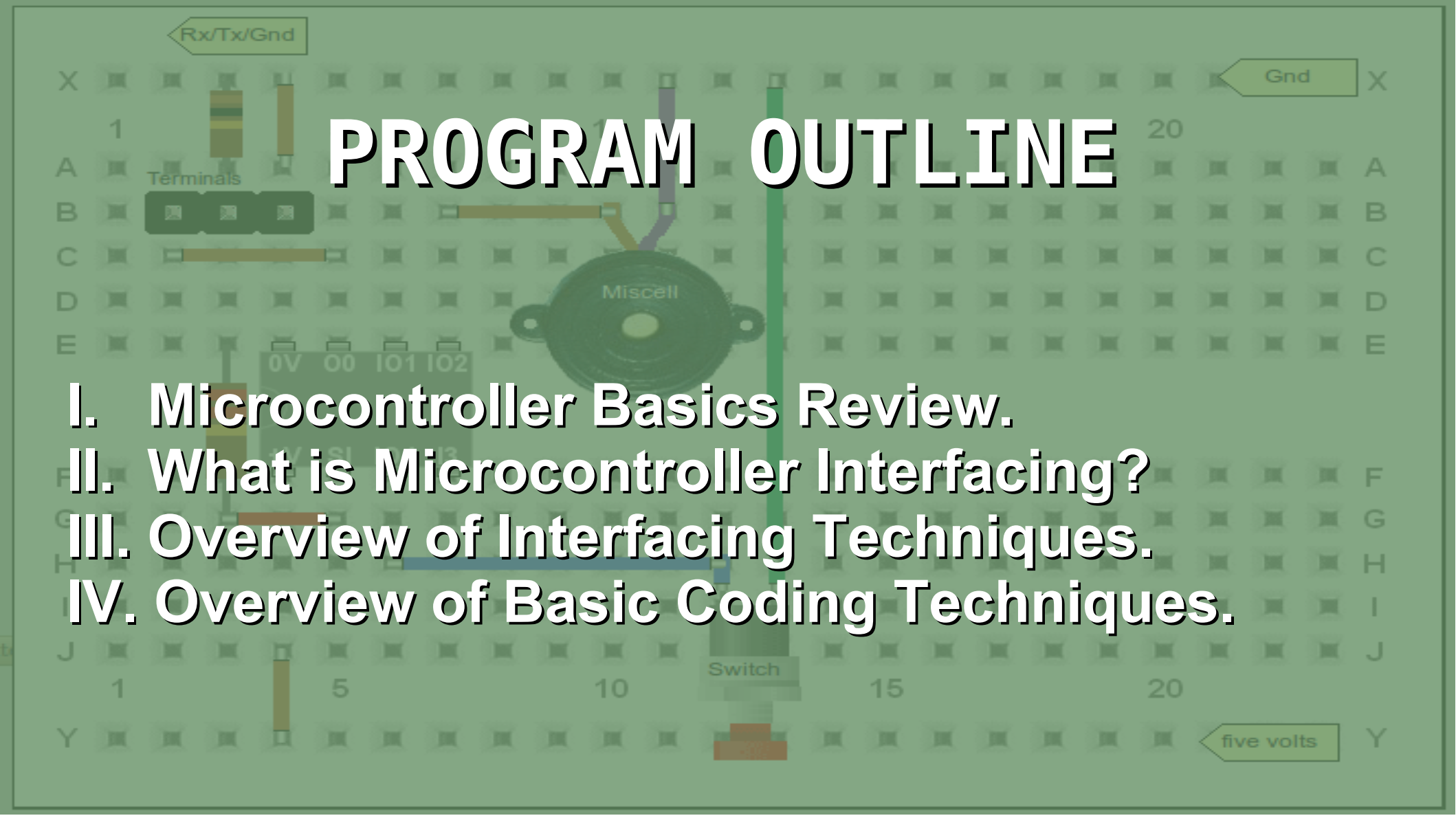
KEY TO THIS PROGRAM

If you like this program:
Fall asleep with your head forward.

If you dislike this program:
Fall asleep with your head backward.

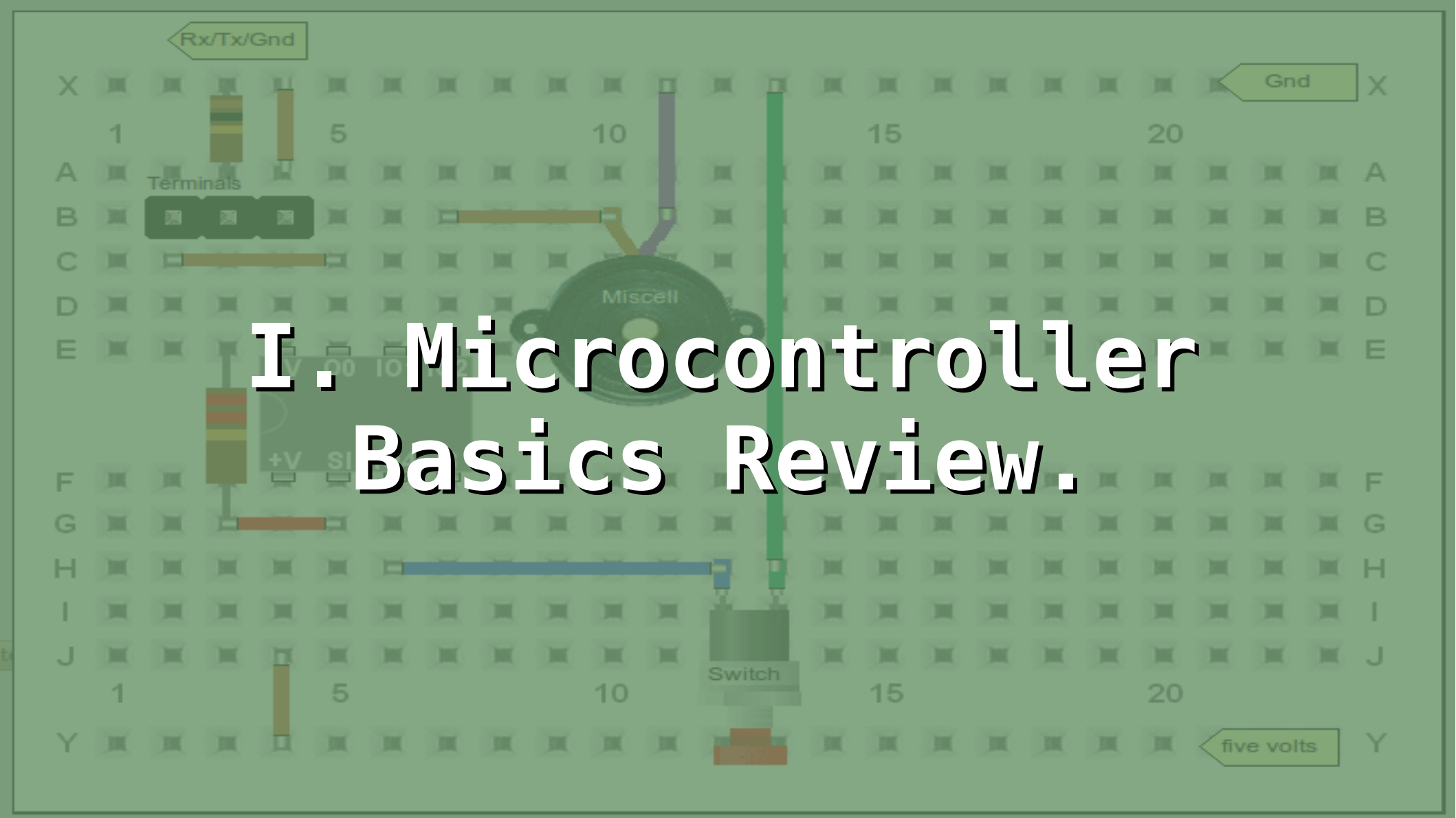
All the heads should be forward when I am finished :-)

Ed Hare W1RFI, 2001



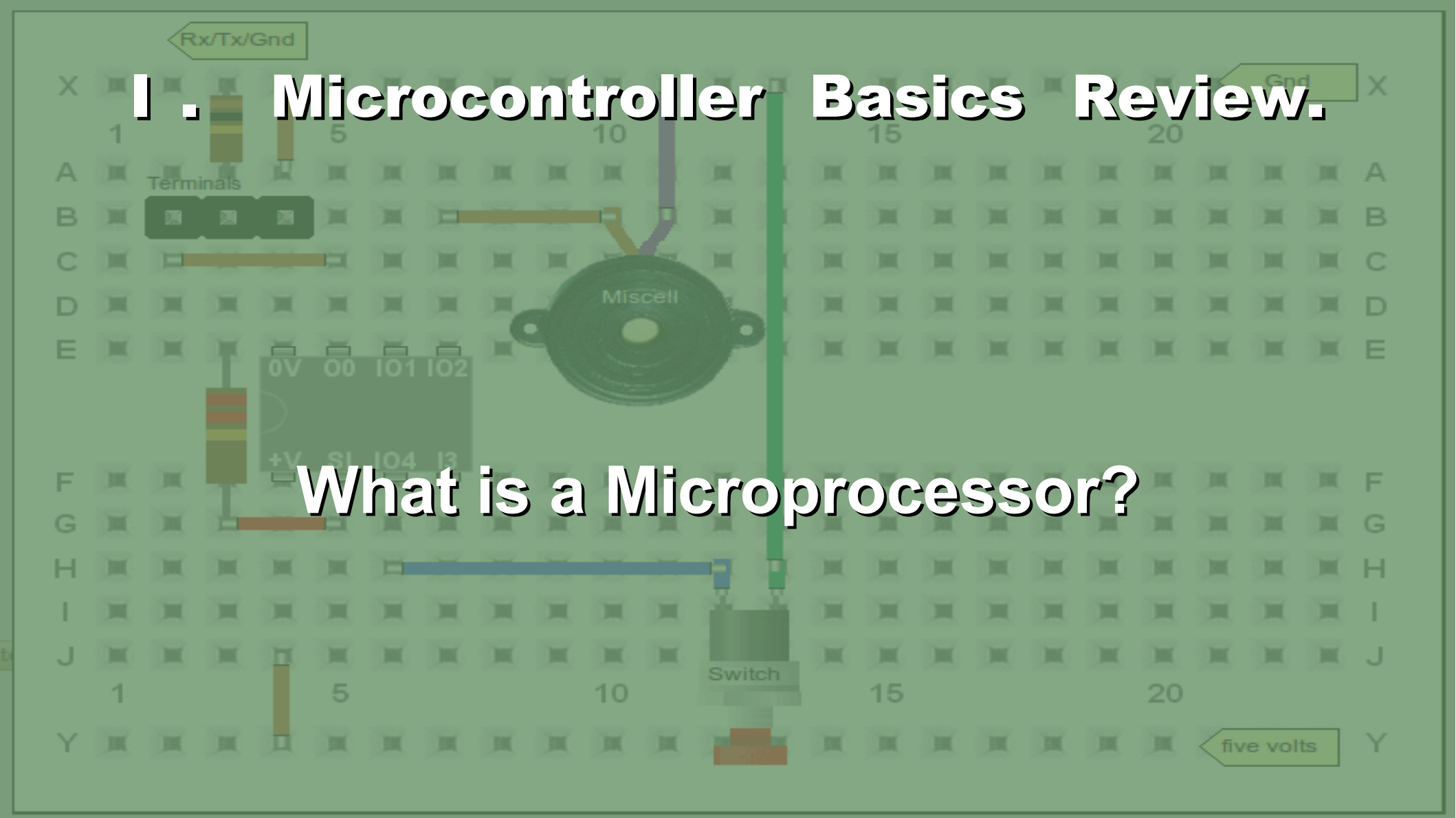
PROGRAM OUTLINE

I. Microcontroller Basics Review.
II. What is Microcontroller Interfacing?
III. Overview of Interfacing Techniques.
IV. Overview of Basic Coding Techniques.



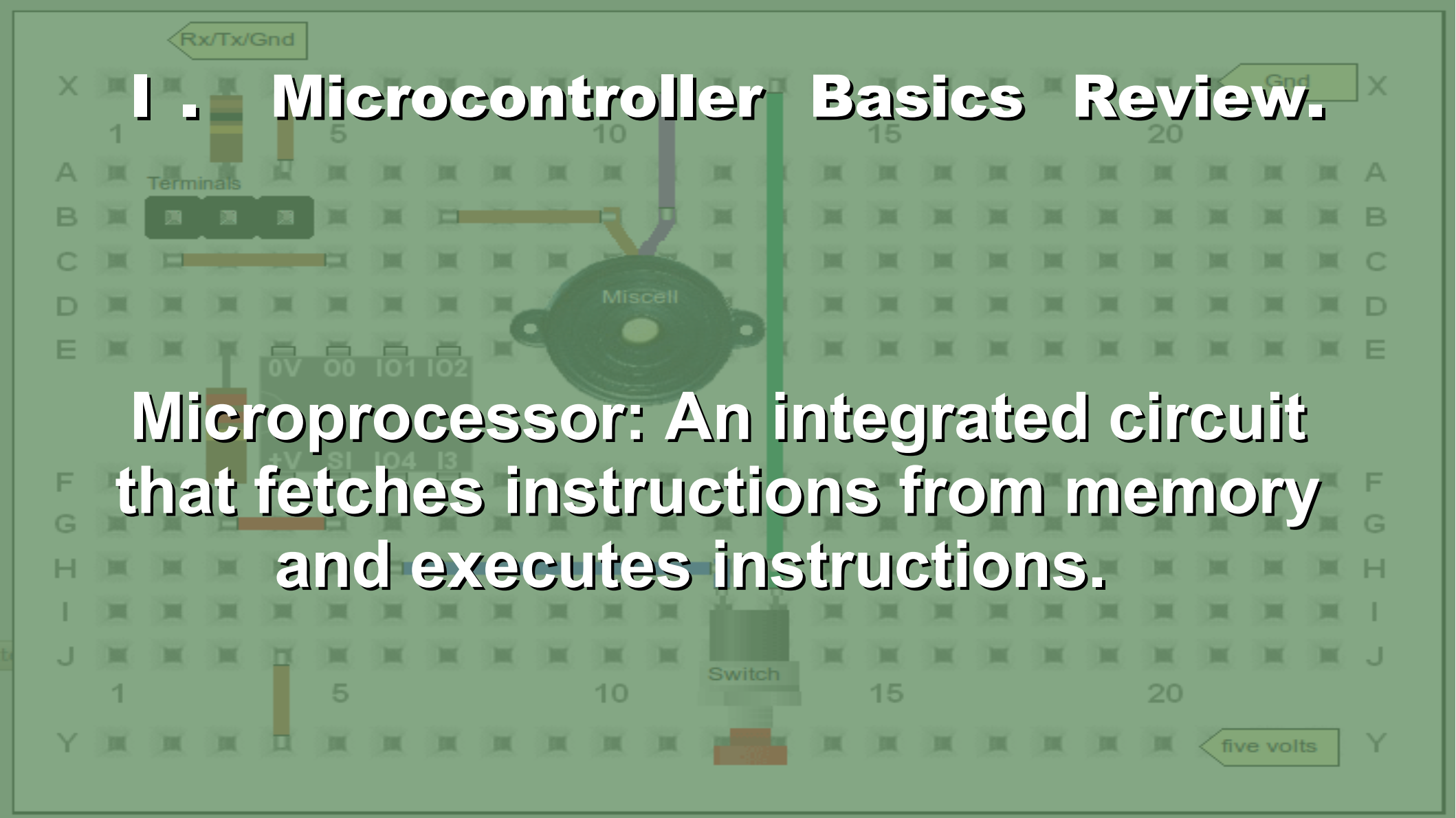
I. Microcontroller Basics Review.

I . Microcontroller Basics Review.



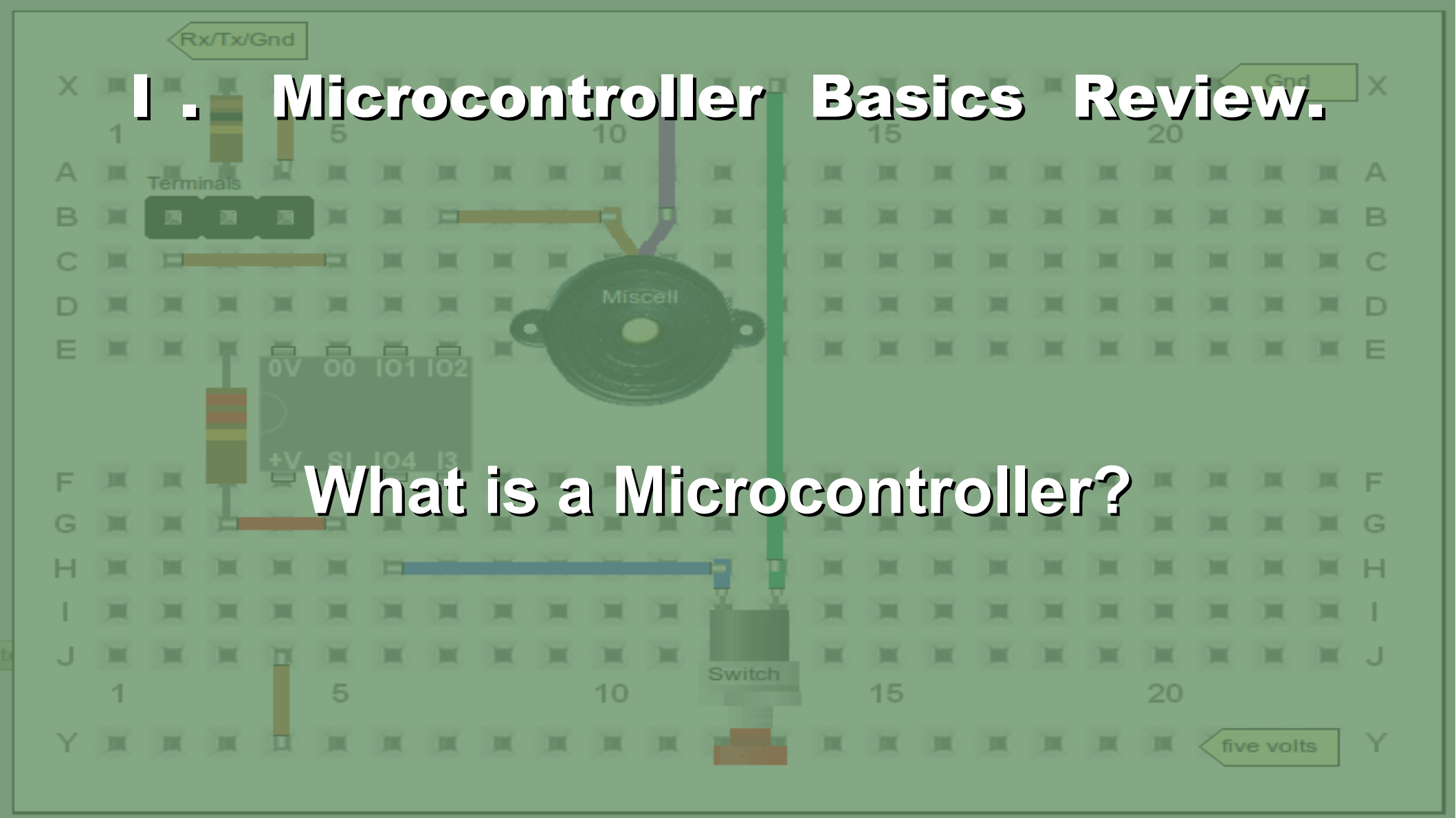
What is a Microprocessor?

I . Microcontroller Basics Review.



Microprocessor: An integrated circuit that fetches instructions from memory and executes instructions.

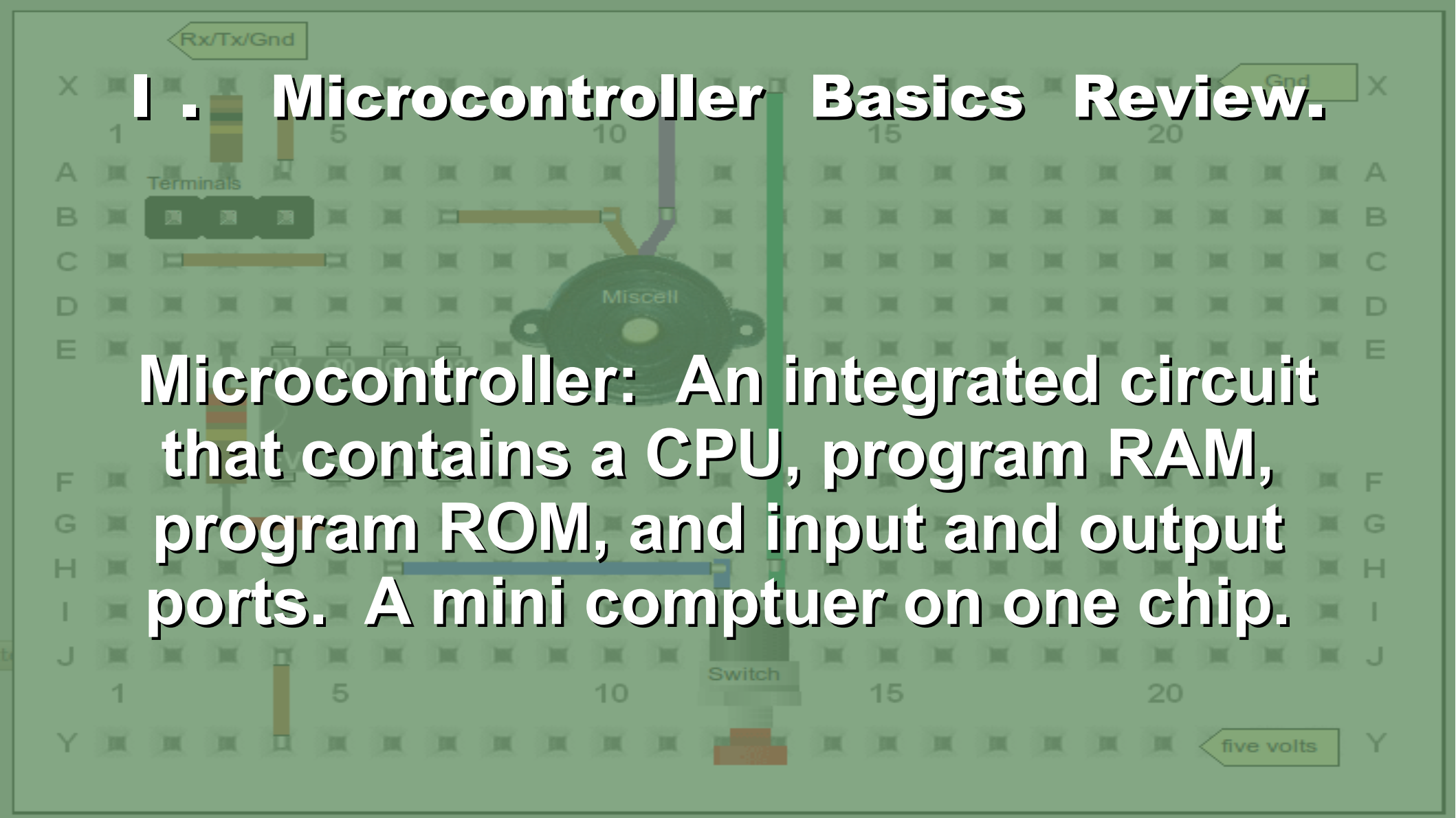
I . Microcontroller Basics Review.



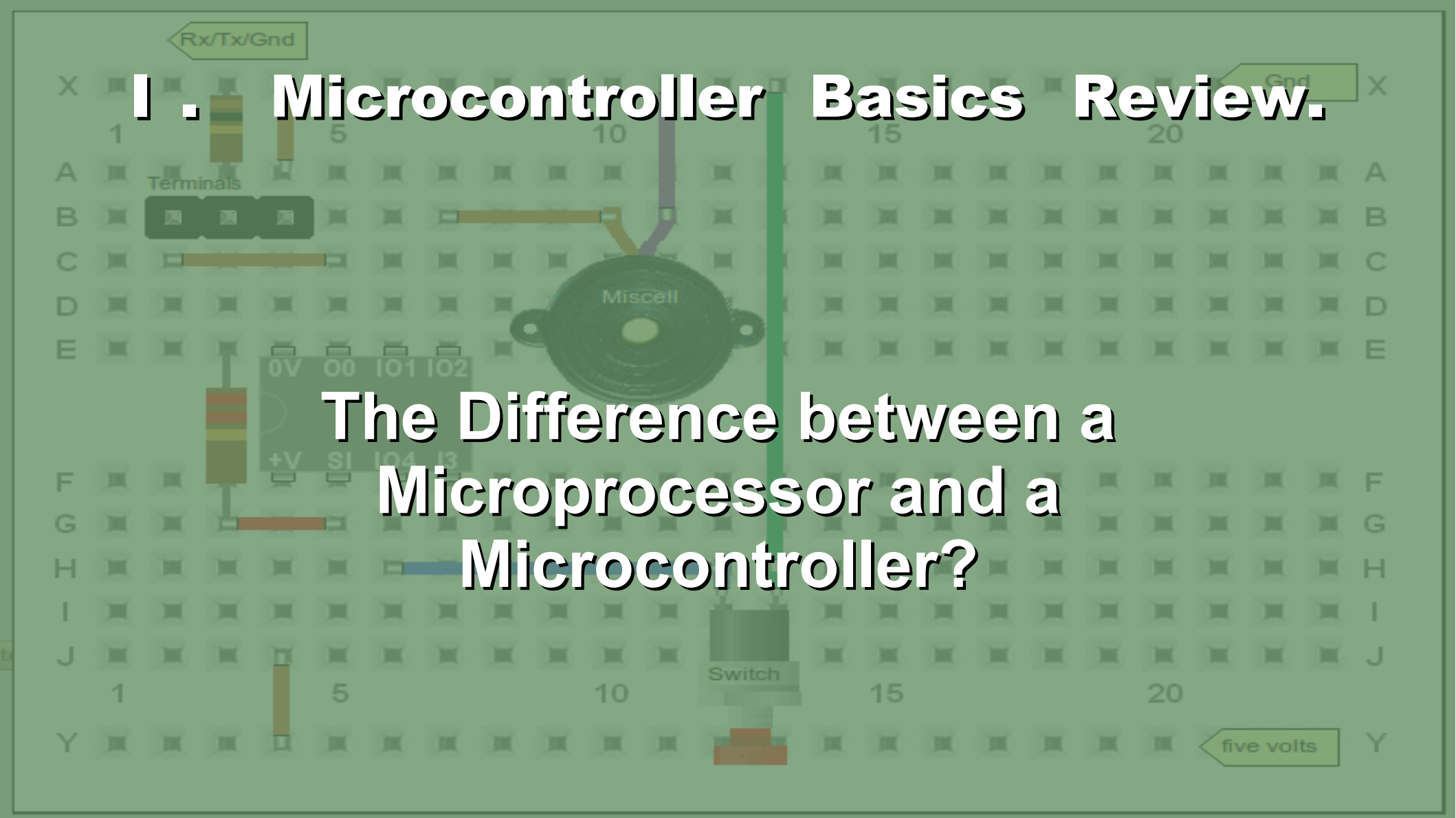
What is a Microcontroller?

I . Microcontroller Basics Review.

Microcontroller: An integrated circuit that contains a CPU, program RAM, program ROM, and input and output ports. A mini comptuer on one chip.



I . Microcontroller Basics Review.

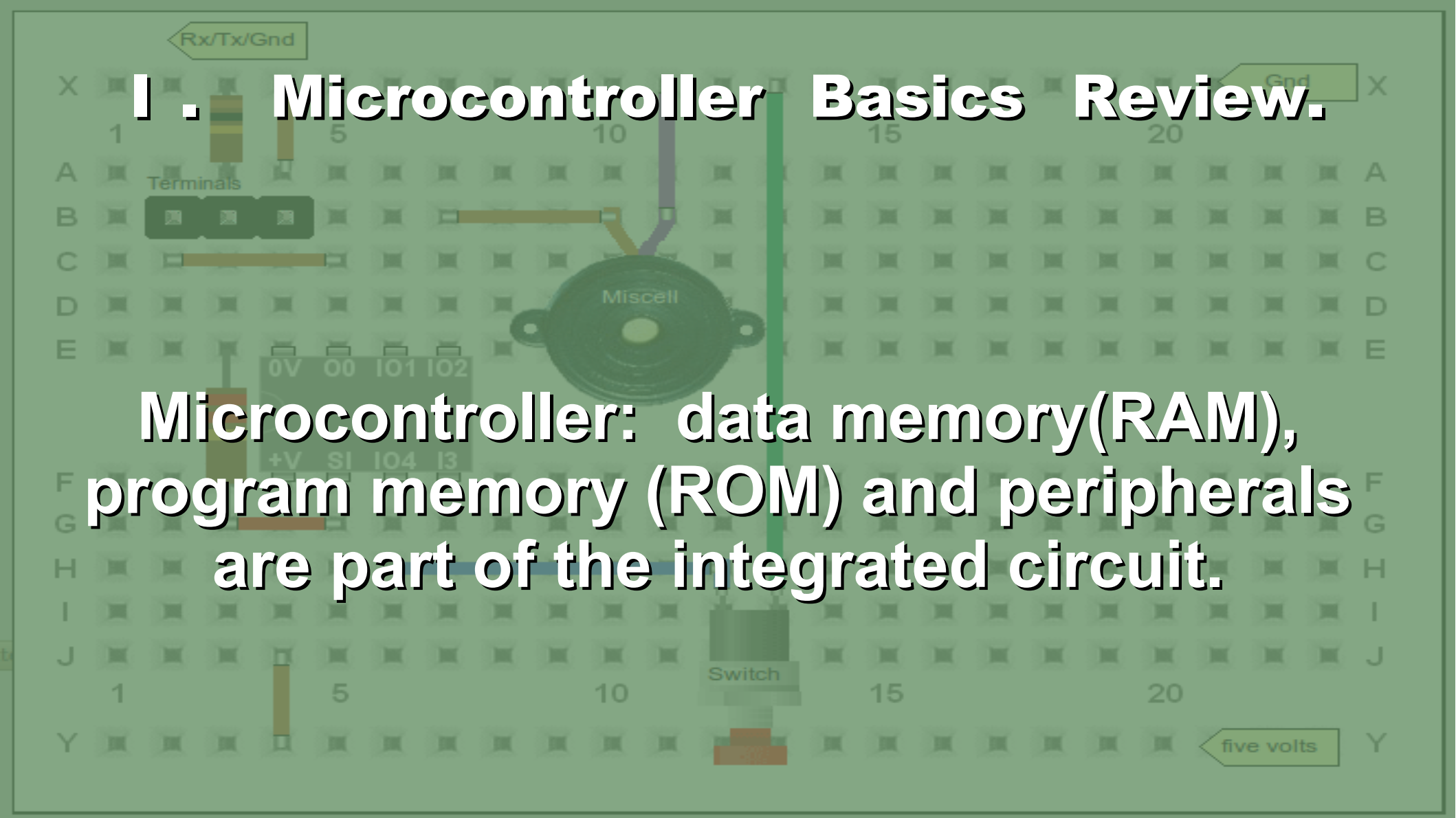


The Difference between a Microprocessor and a Microcontroller?

I . Microcontroller Basics Review.

Microprocessor: data memory (RAM), program memory (ROM), and peripherals are outside the integrated circuit.

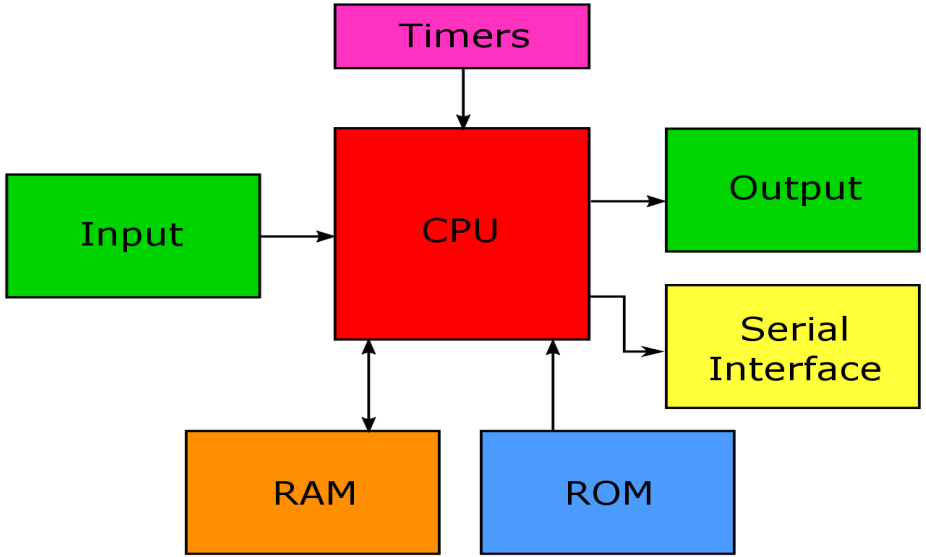
I . Microcontroller Basics Review.



Microcontroller: data memory(RAM), program memory (ROM) and peripherals are part of the integrated circuit.

I . Microcontroller Basics Review.

Microprocesser: CPU
and several supporting chips.



Microcontroller: CPU
on a single chip.

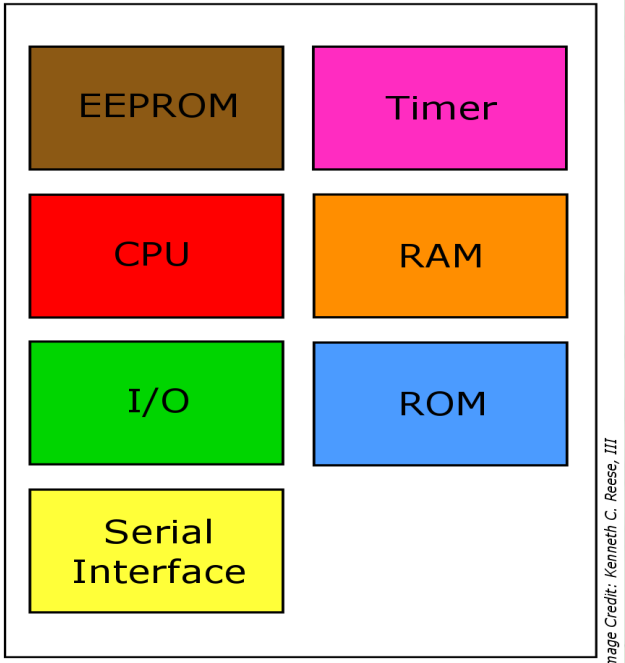
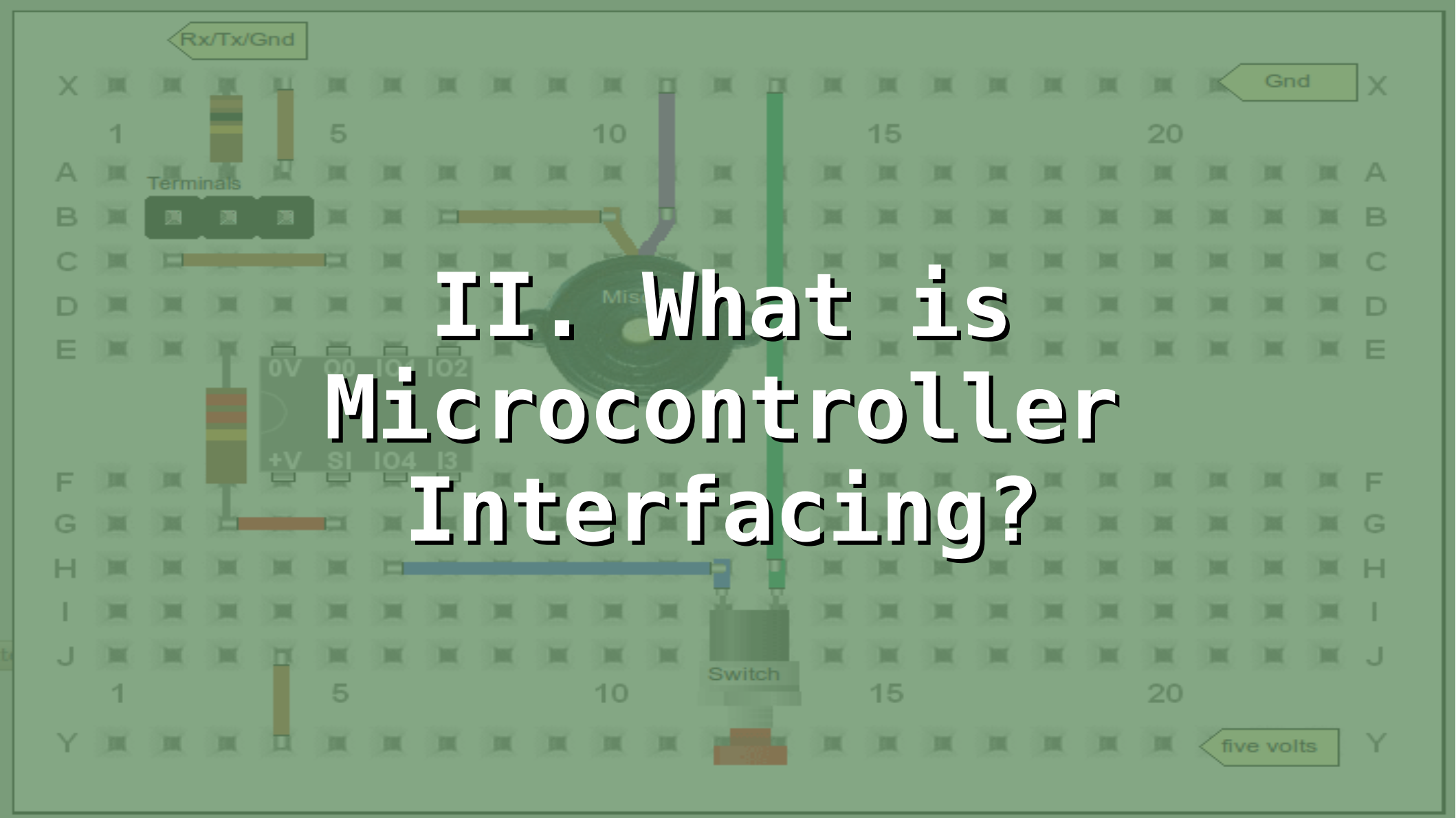
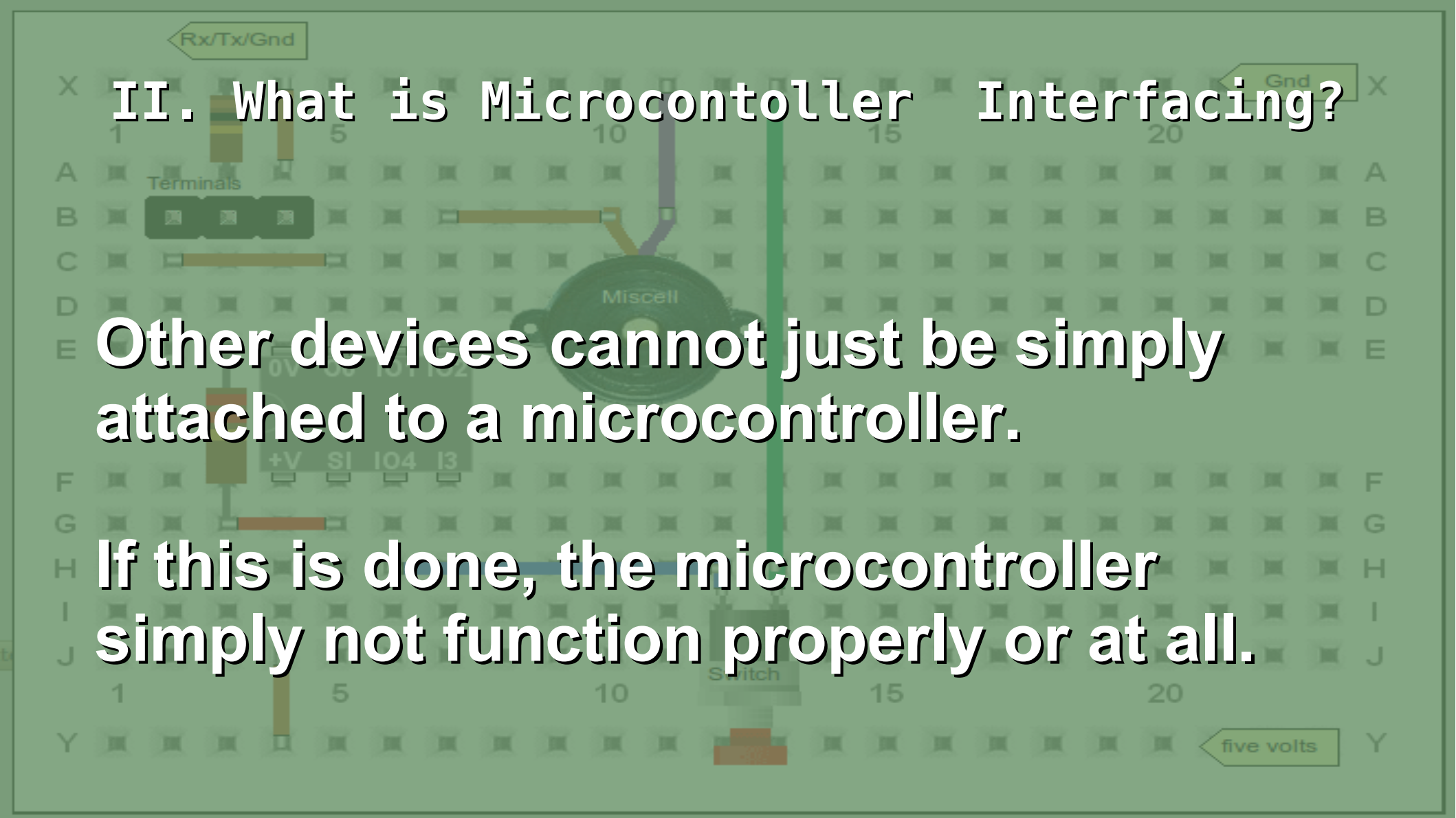


Image Credit: Kenneth C. Reese, III



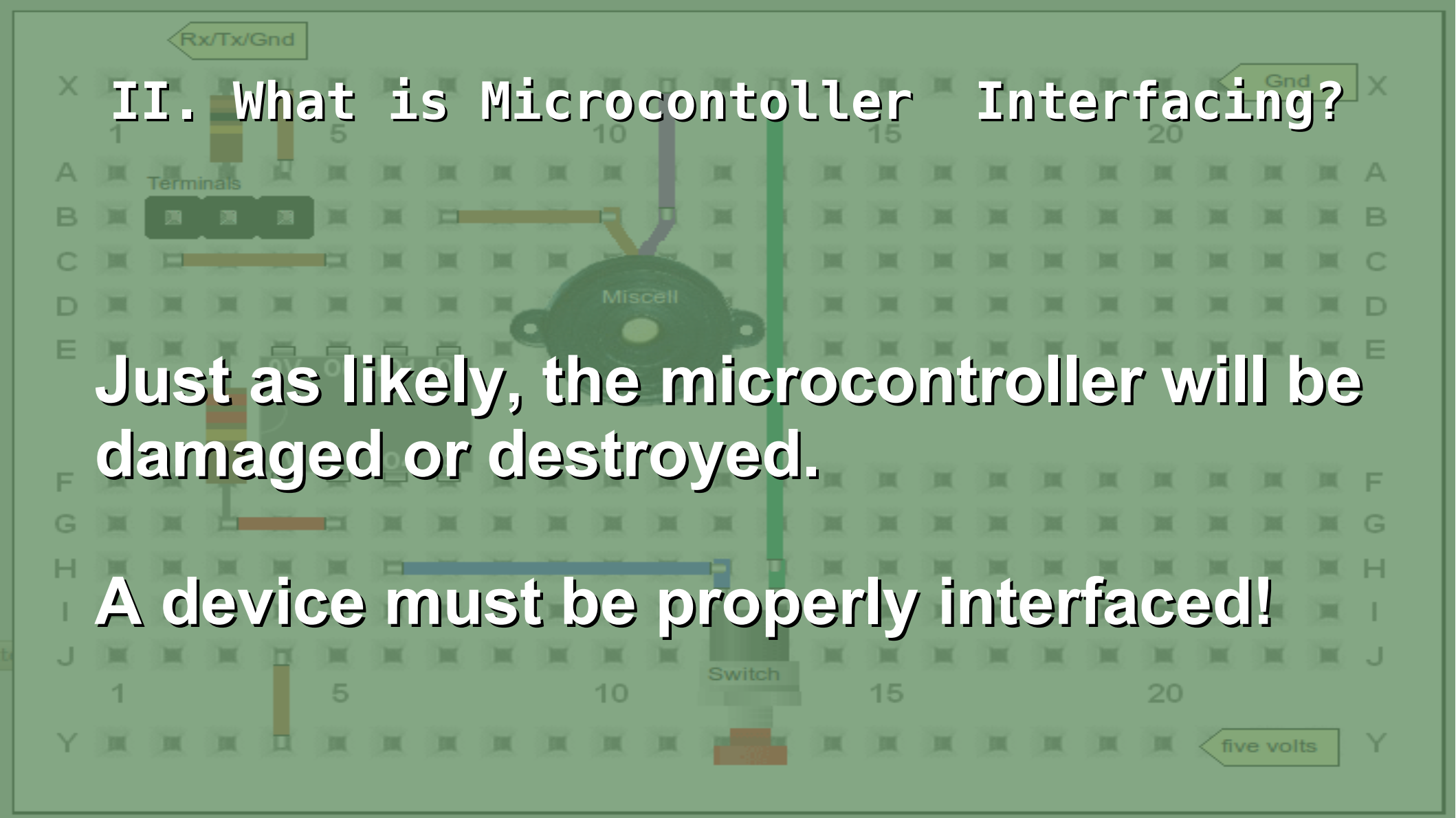
II. What is Microcontroller Interfacing?

II. What is Microcontoller Interfacing?



Other devices cannot just be simply attached to a microcontroller.

If this is done, the microcontroller simply not function properly or at all.



II. What is Microcontoller Interfacing?

Just as likely, the microcontroller will be damaged or destroyed.

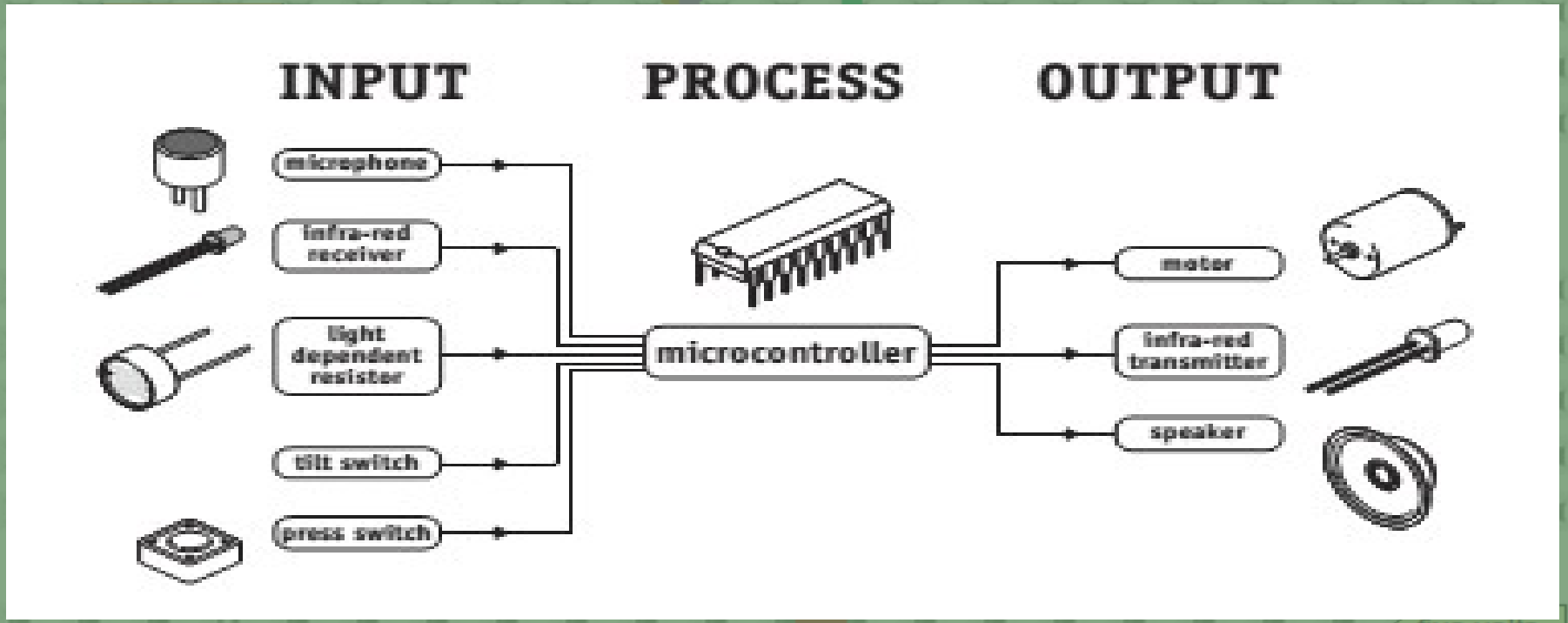
A device must be properly interfaced!

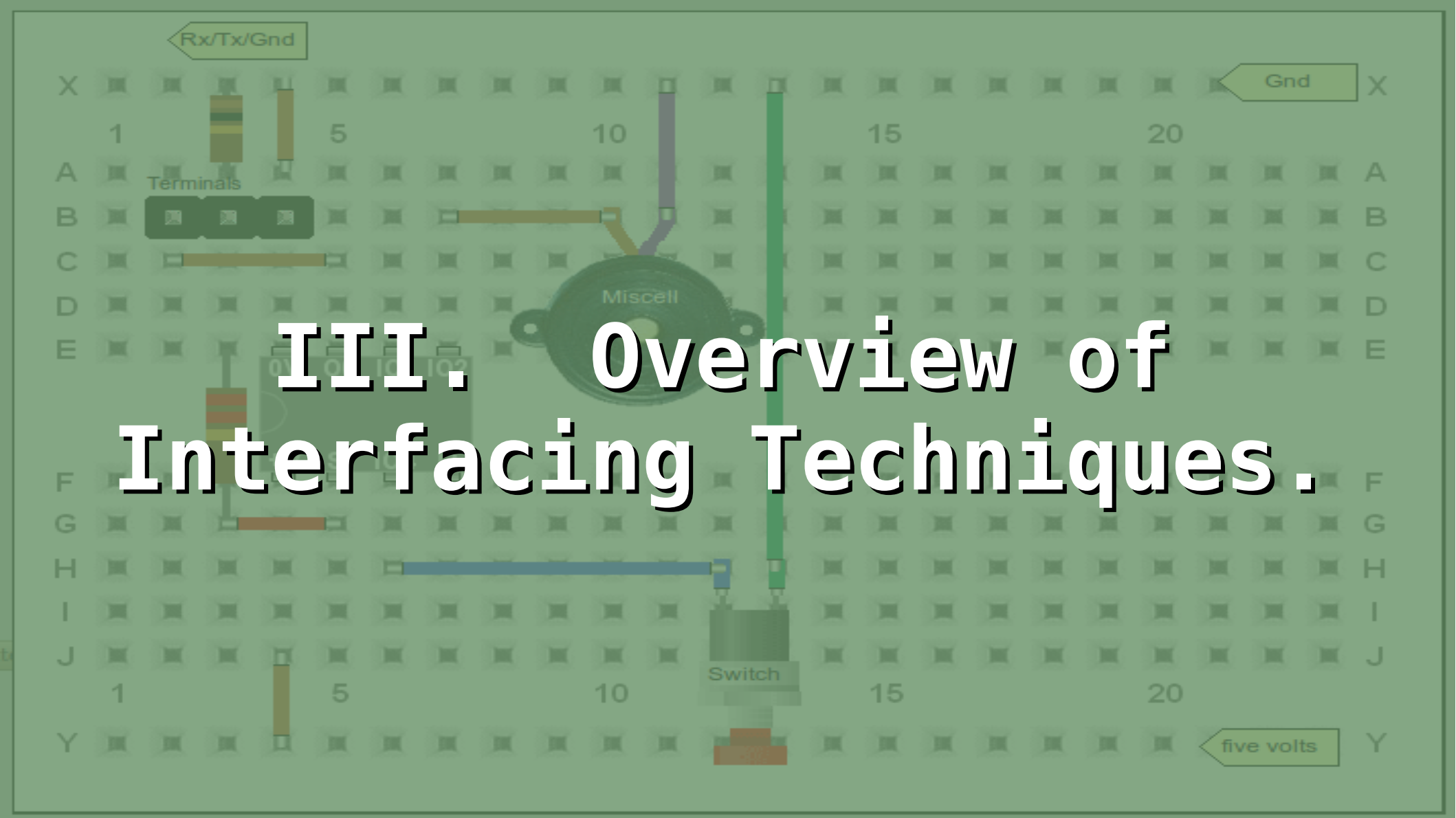
II. What is Microcontoller Interfacing?

Microcontroller interfaces are in three general categories:

- **Output Interfaces.**
- **Input Interfaces.**
- **Advanced Interfaces.**

II. What is Microcontoller Interfacing?





III. Overview of Interfacing Techniques.

III. Overview of Intefacing Techniques.

These interface techniques are used with virtually all microcontroller platforms on the market today!

These techniques are not all the techniques available, but just the most popular ones.

III. Overview of Intefacing Techniques.

The following example use “pseudocode”.

The graphics used in this section come from the PICAXE Basic Manual #3:

https://picaxe.com/getting-started/picaxe-manuals/

III. Overview of Intefacing Techniques.

Output Interfaces

The following are examples of common output interfaces.

There are many more ways to interface outputs.

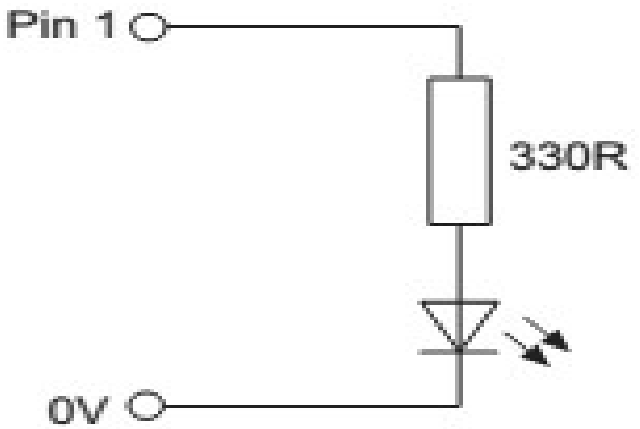
III. Overview of Intefacing Techniques.

Output Technique #1: LED – High Active

LED connected to Ground Rail.

To switch on LED - `high 1`

To switch off LED - `low 1`



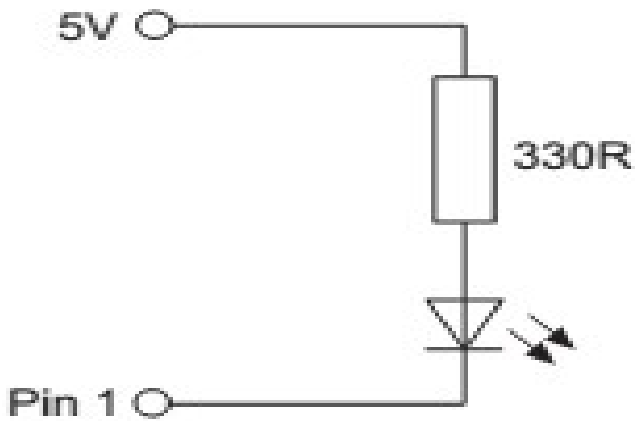
III. Overview of Intefacing Techniques.

Output Technique #2: LED – Low Active

LED connected to Power Rail.

To switch on LED – `low 1`

To switch off LED – `high 1`



III. Overview of Intefacing Techniques.

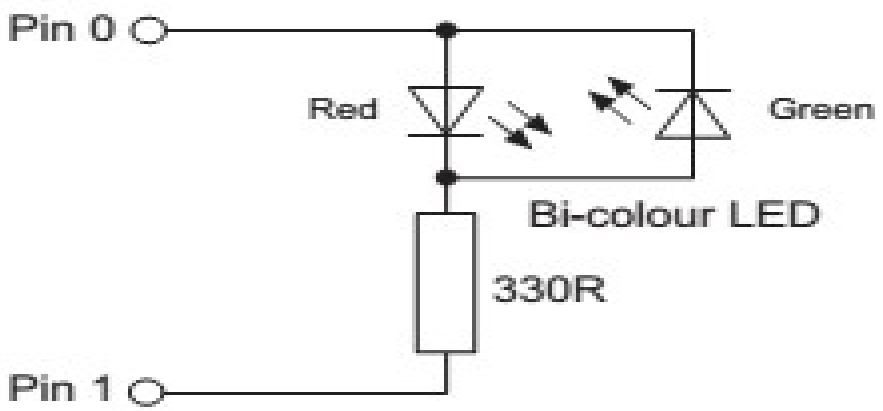
Output Technique #3: Bi-Color LED

To switch on LED in red - high 0
low 1

To switch on LED in green - low 0
high 1

To switch off LED - low 0
low 1

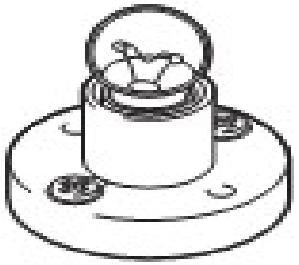
or, high 0
high 1



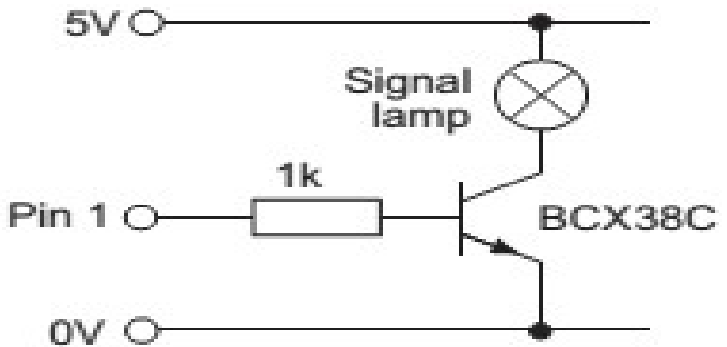
III. Overview of Intefacing Techniques.

Output Technique #4: Lamp

To switch on Lamp - `high 1`
To switch off Lamp - `low 1`



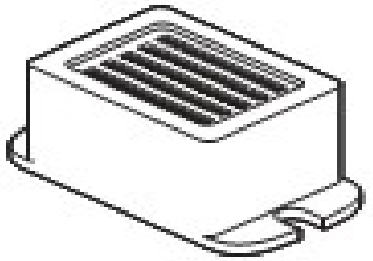
signal lamp



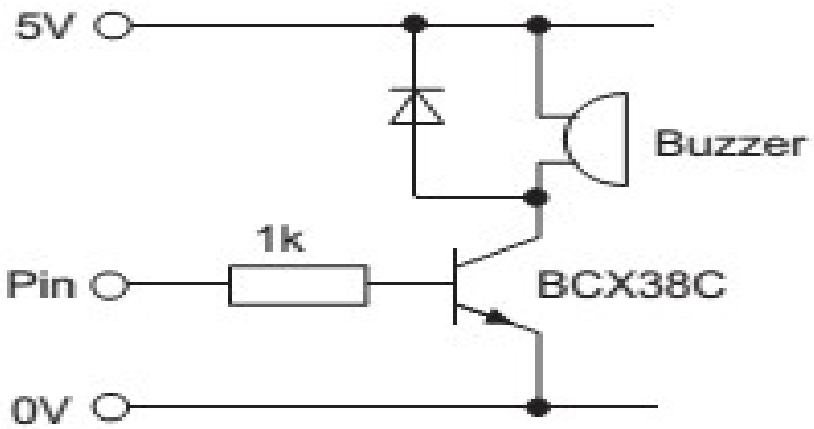
III. Overview of Intefacing Techniques.

Output Technique #5: Sound with Buzzer

```
To switch on buzzer -     high 1
To switch off buzzer -    low 1
```

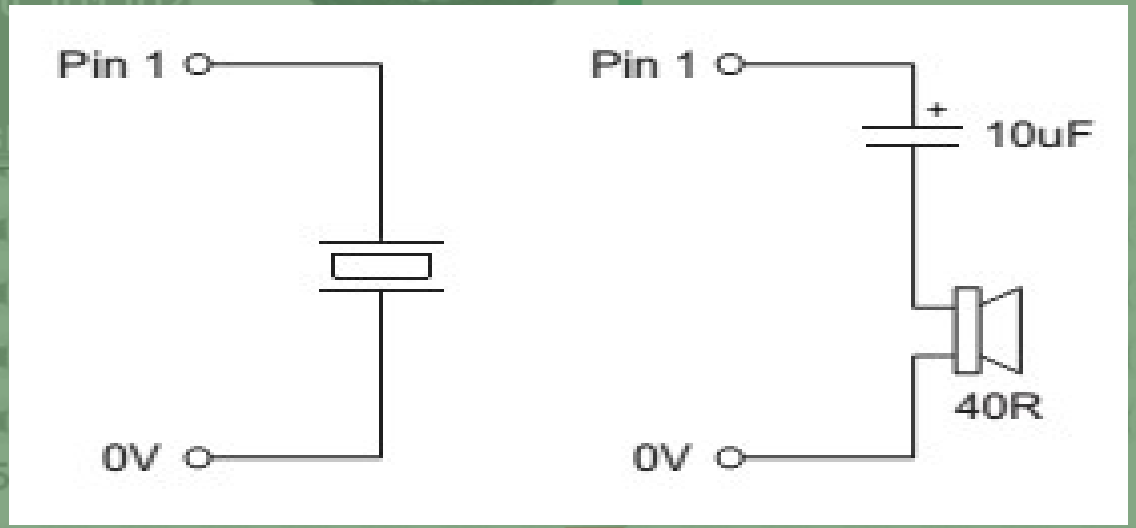


buzzer



III. Overview of Intefacing Techniques.

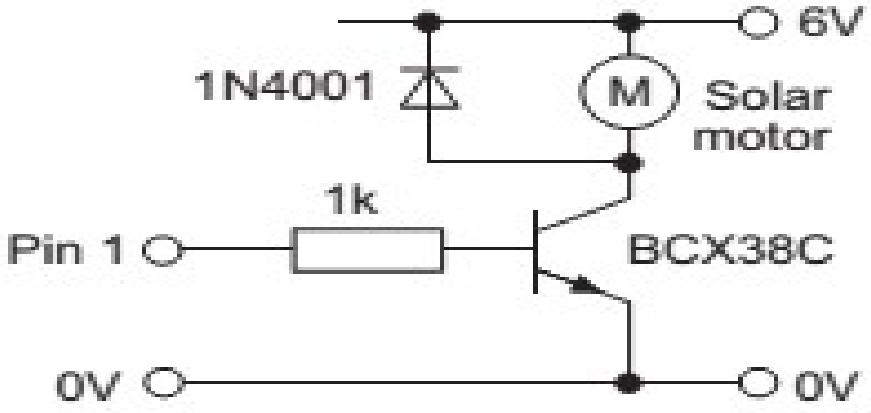
Output Technique #6: Sound Output with Piezo Buzzer or Speaker.



III. Overview of Intefacing Techniques.

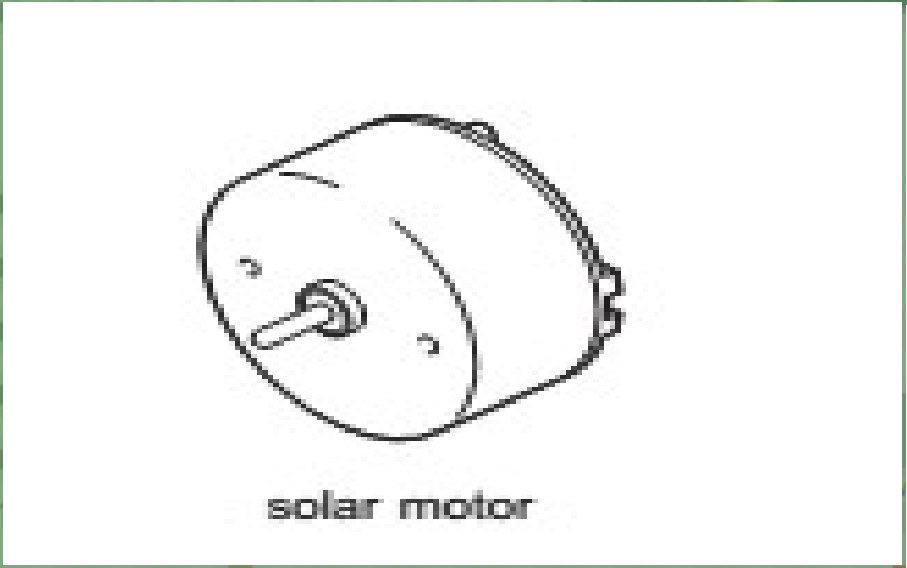
Output Technique #7:
Turning a Motor On and Off – Light Duty

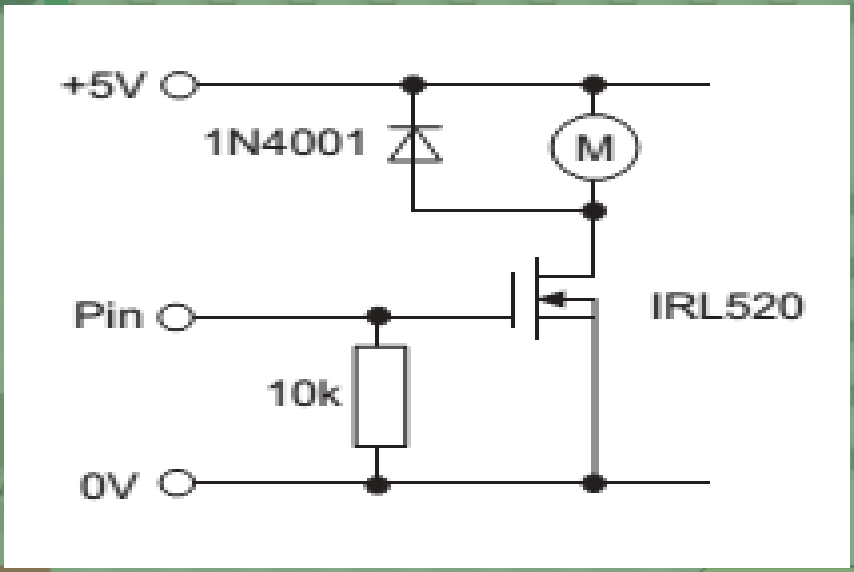
solar motor



III. Overview of Intefacing Techniques.

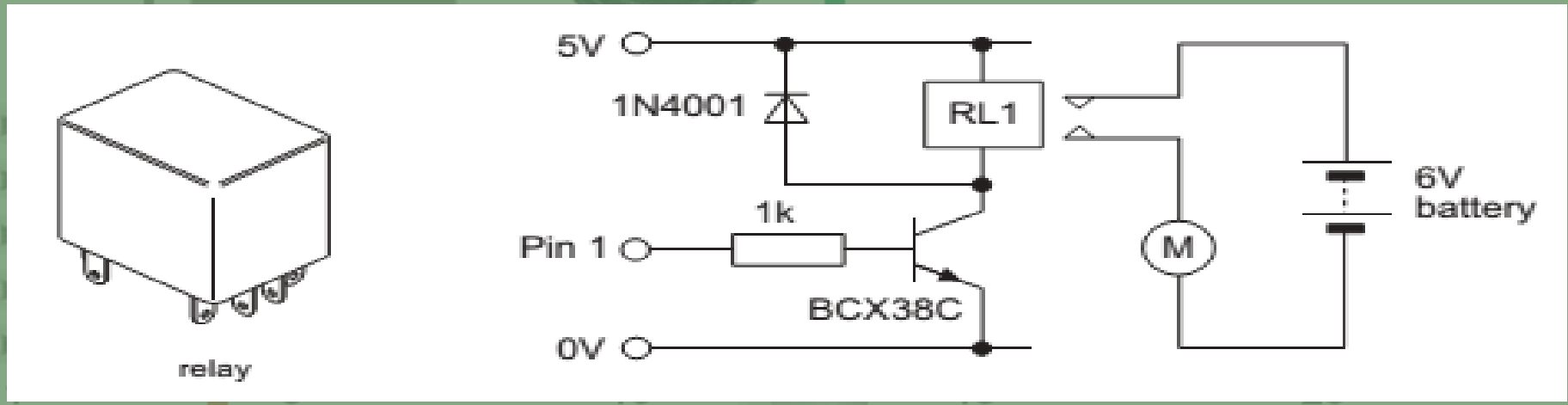
Output Technique #8:
Turning a Motor On and Off – Heavy Duty





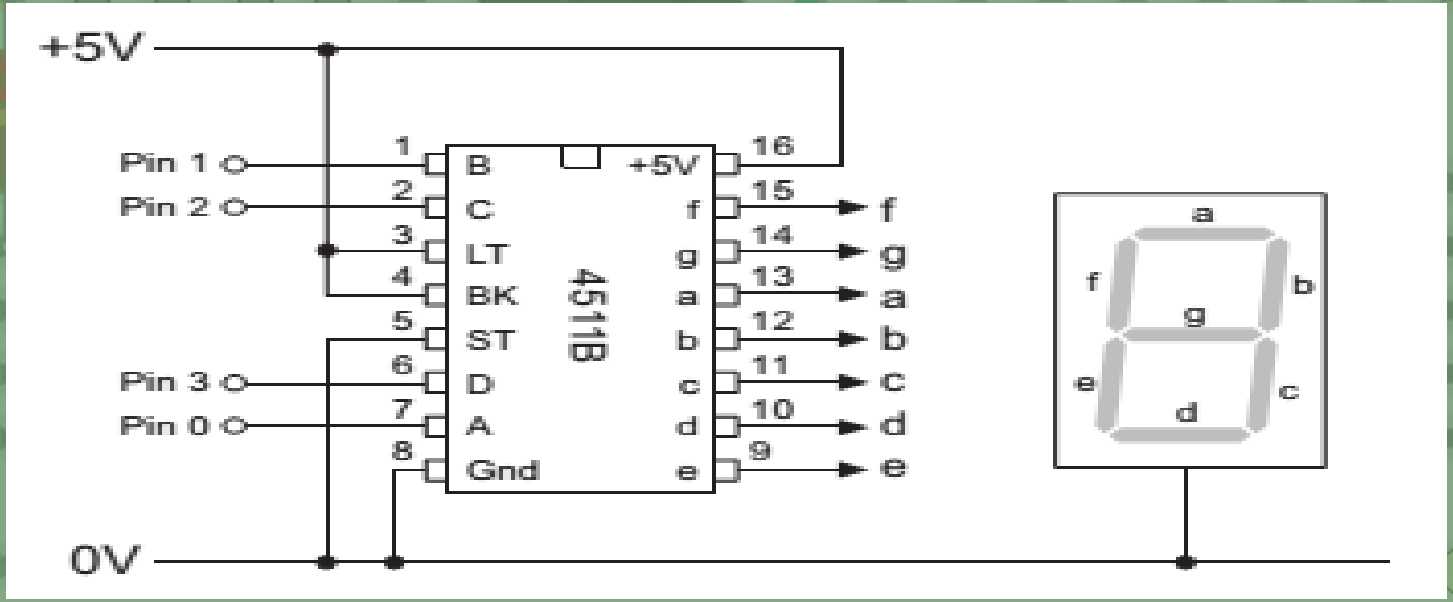
III. Overview of Intefacing Techniques.

Output Technique #9: Turning on a Relay to Control loads.



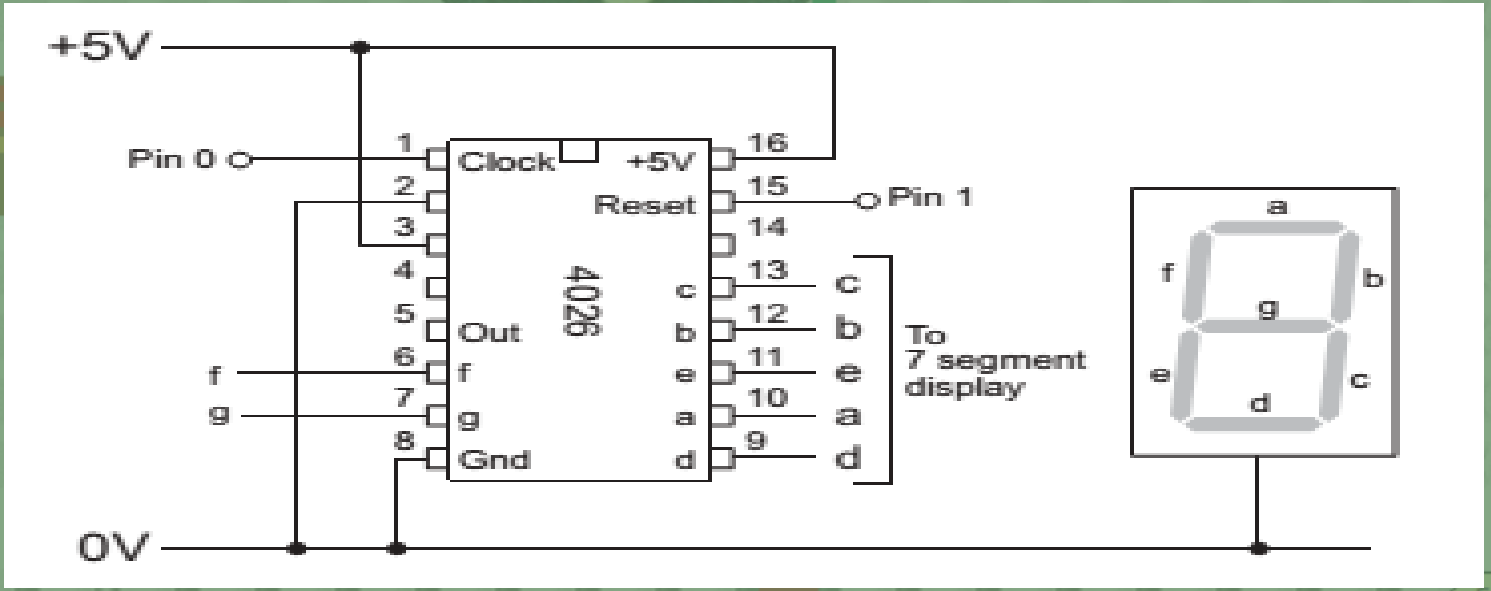
III. Overview of Intefacing Techniques.

Output Technique #10: Seven Segment LED Display - BCD Input.



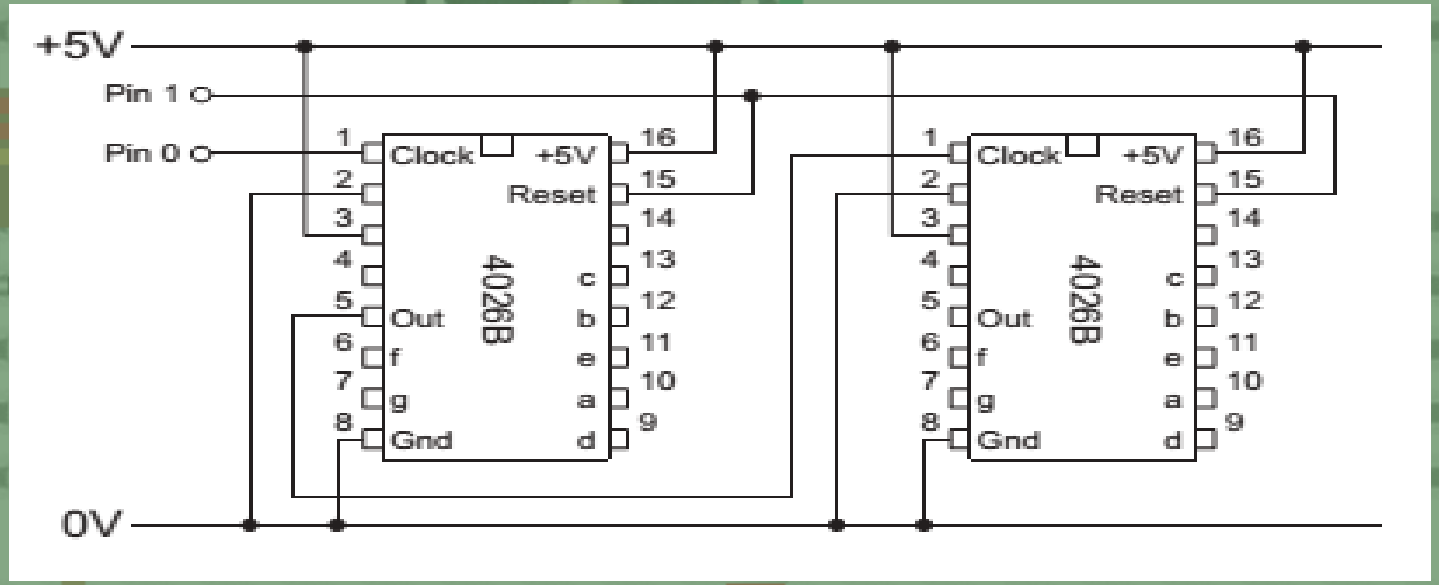
III. Overview of Intefacing Techniques.

Output Technique #11:
Seven Segment LED Display: Clock.



III. Overview of Intefacing Techniques.

Output Technique #12:
Two 7 Segment LED Display: Clock.

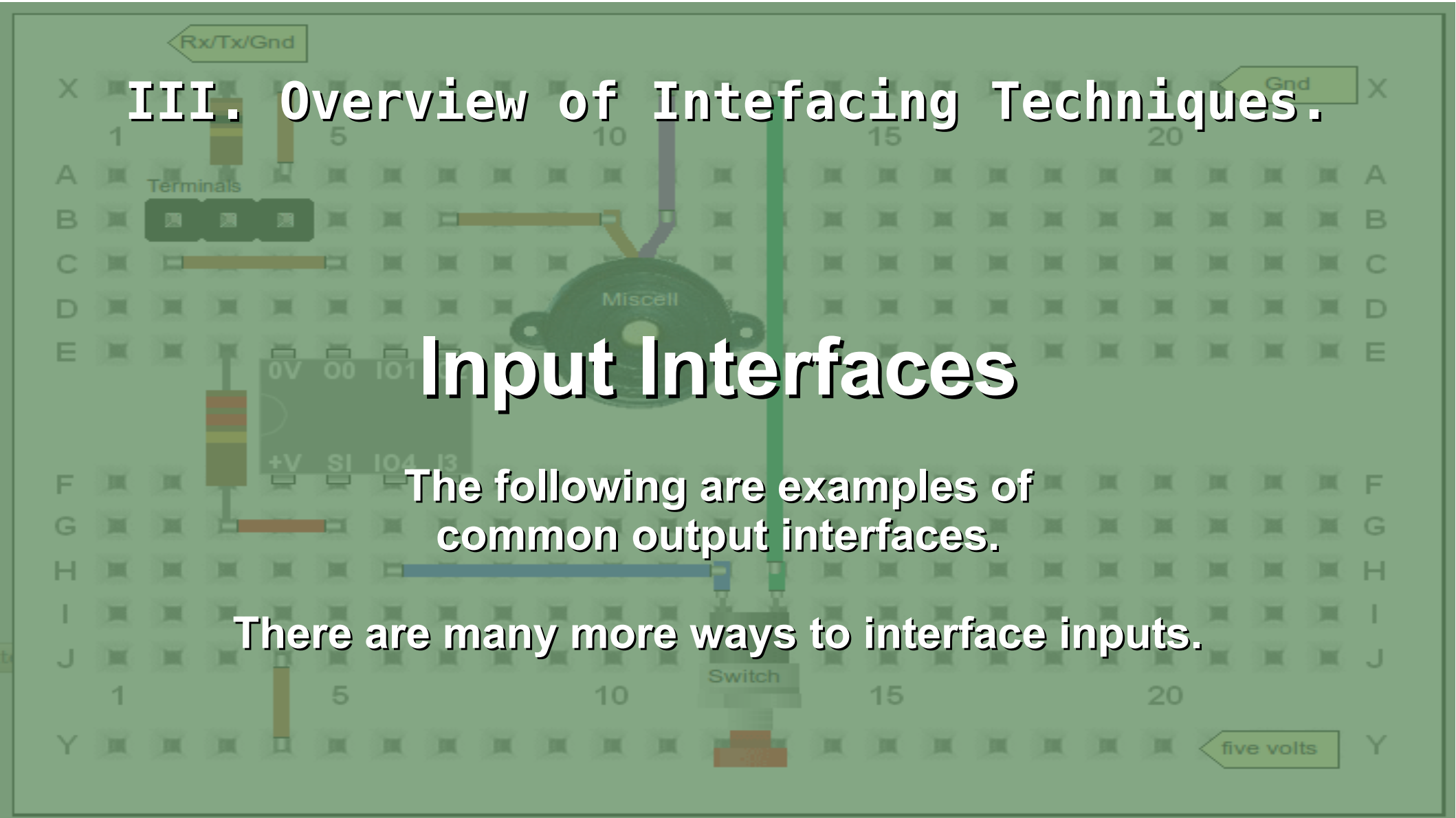


III. Overview of Intefacing Techniques.

Input Interfaces

The following are examples of common output interfaces.

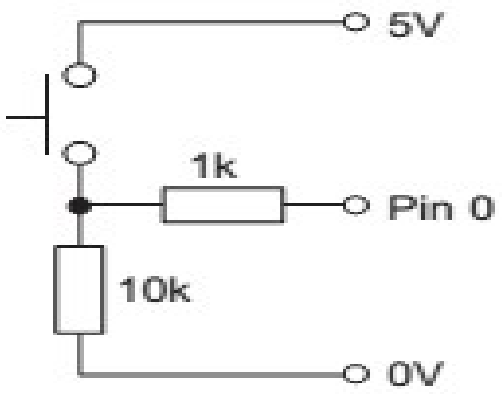
There are many more ways to interface inputs.



III. Overview of Intefacing Techniques.

Input Technique #1: Switch – Active High.

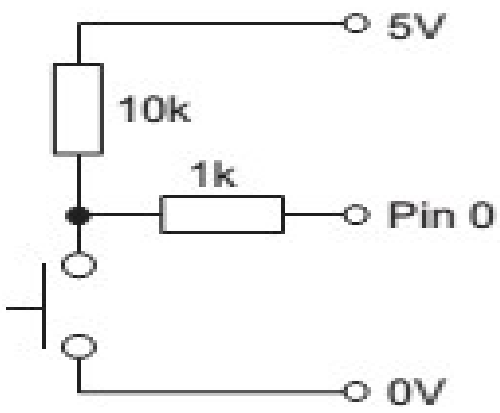
Goto 'jump' when switch is open: if pin0 = 0 then jump
Goto 'jump' when switch is closed: if pin0 = 1 then jump



III. Overview of Intefacing Techniques.

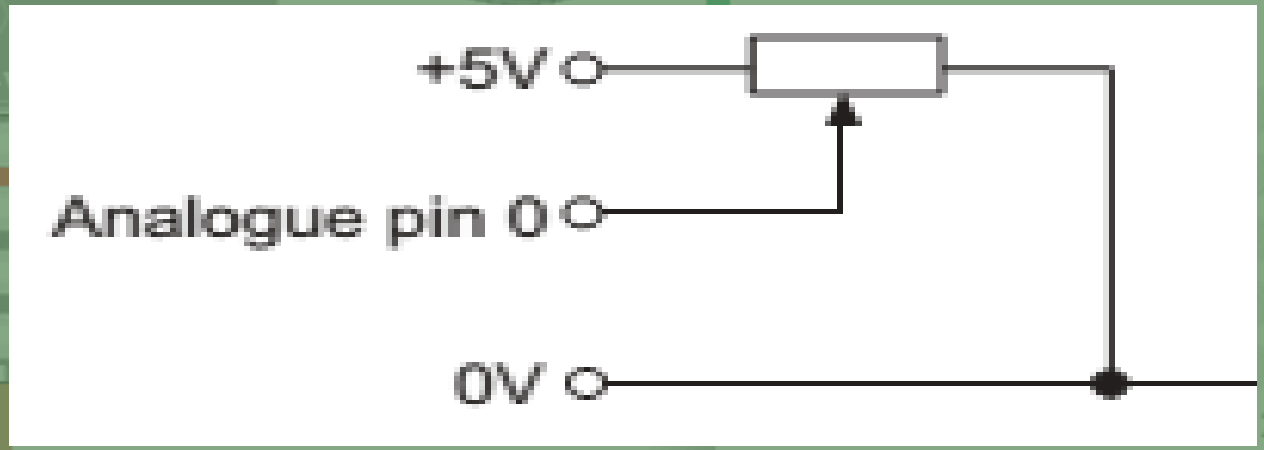
Input Technique #2: Switch – Active Low.

Goto 'jump' when switch is open: if pin0 = 1 then jump
Goto 'jump' when switch is closed: if pin0 = 0 then jump



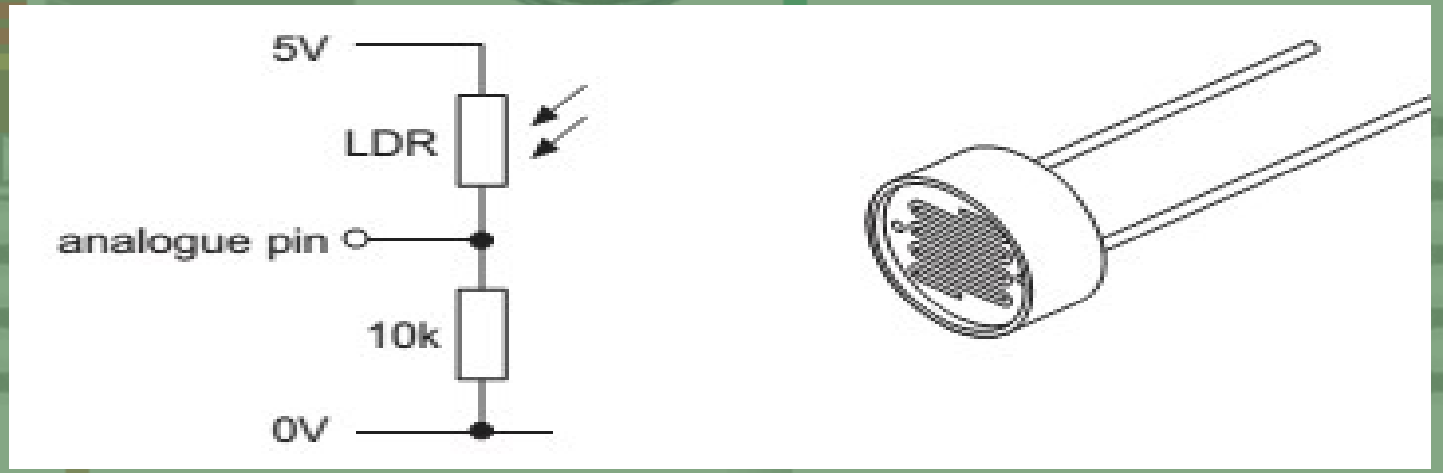
III. Overview of Intefacing Techniques.

Input Technique #3: Analog Voltage (0-5 VDC).



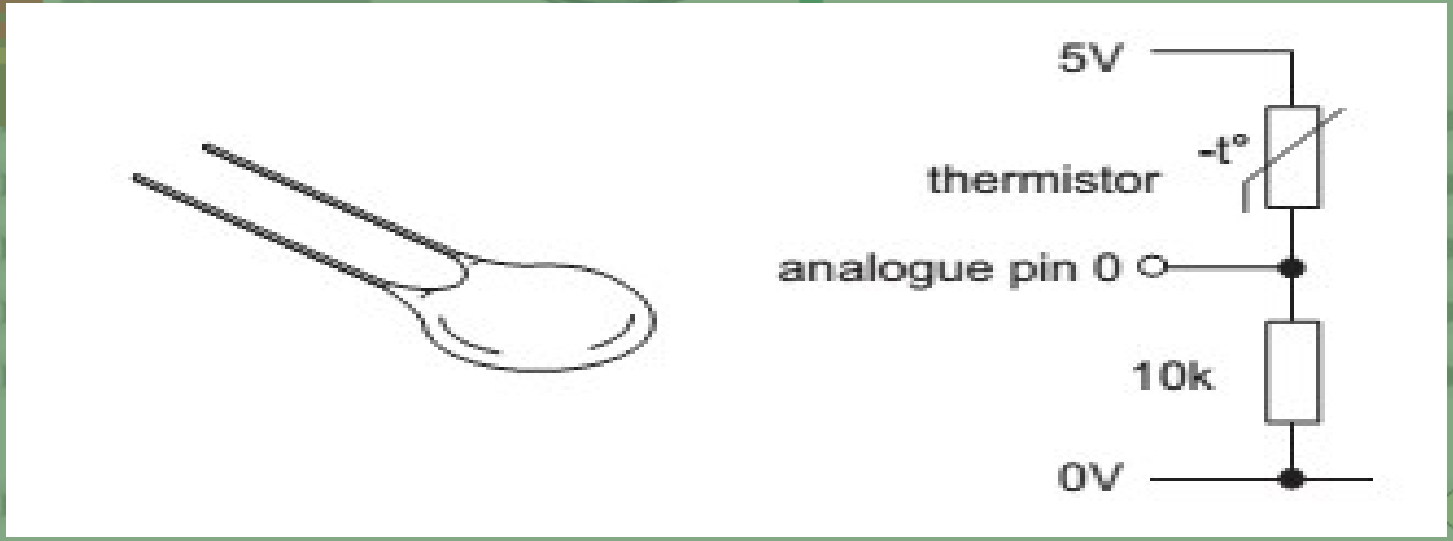
III. Overview of Intefacing Techniques.

Input Technique #4:
Light Sensor (CdS Cell – Photoresistor).



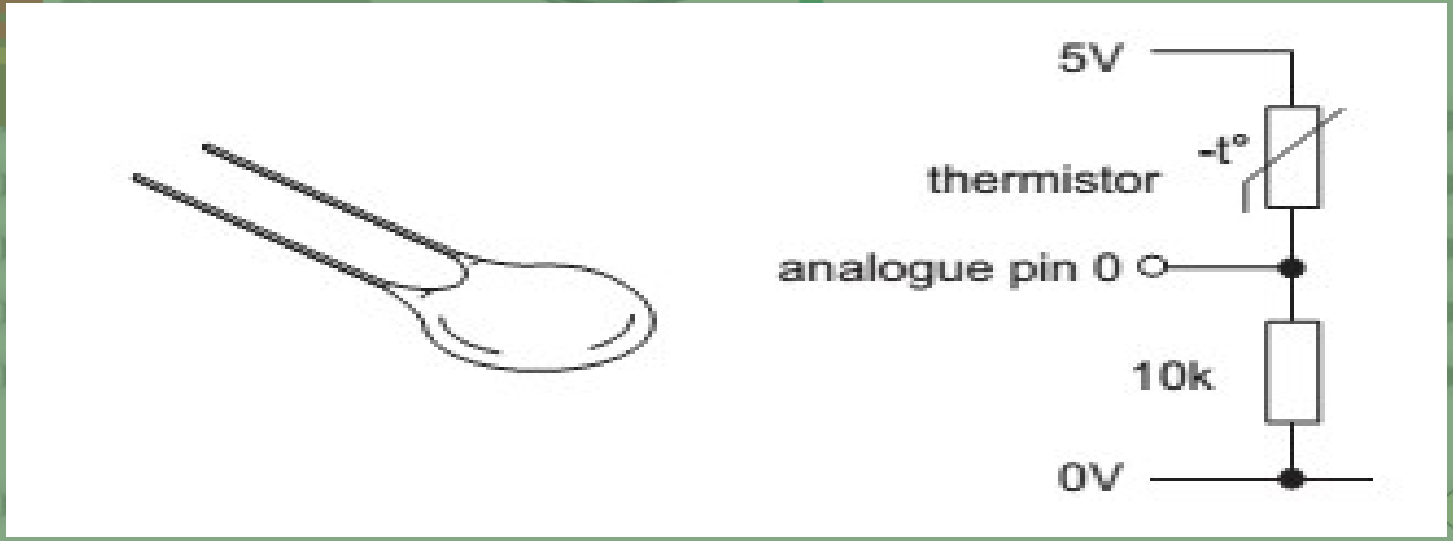
III. Overview of Intefacing Techniques.

Input Technique #5:
Tempature Sensor (Thermistor).



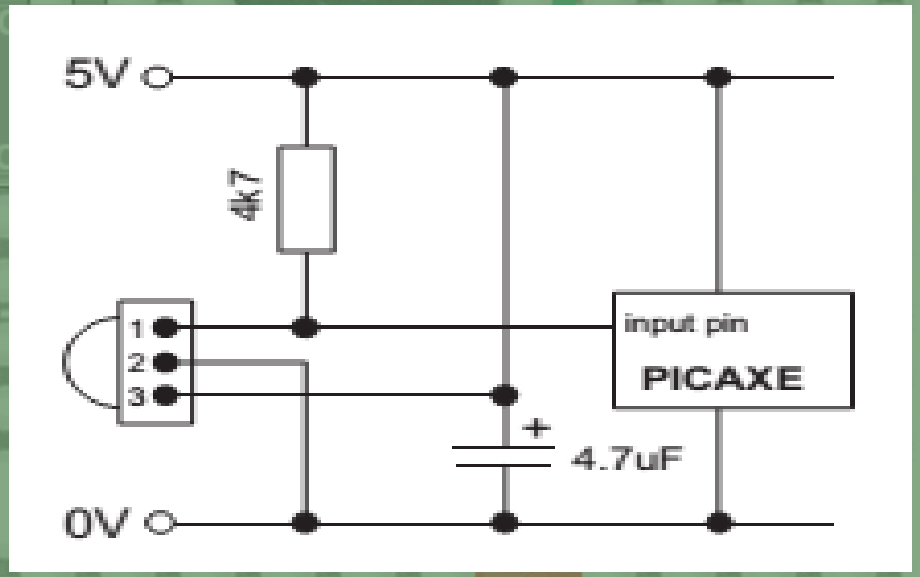
III. Overview of Intefacing Techniques.

Input Technique #5:
Tempature Sensor (Thermistor).



III. Overview of Intefacing Techniques.

Input Technique #6: Infrared Receiver.



III. Overview of Intefacing Techniques.

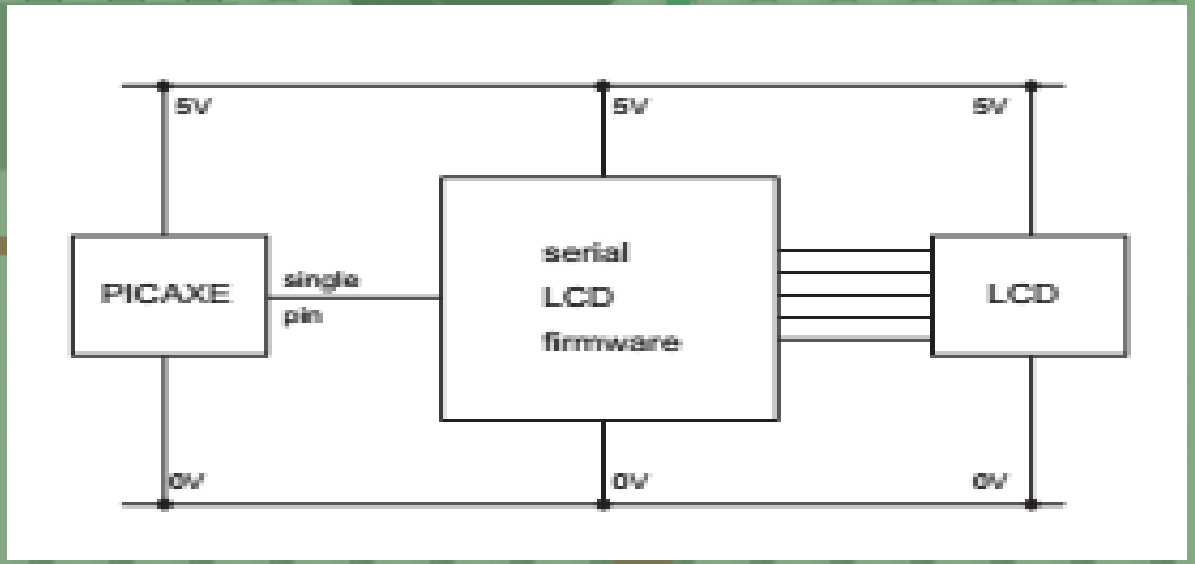
Advanced Interfaces

The following are examples of advanced interfaces that use input and output from a microcontroller.

III. Overview of Intefacing Techniques.

Advanced Technique #1:

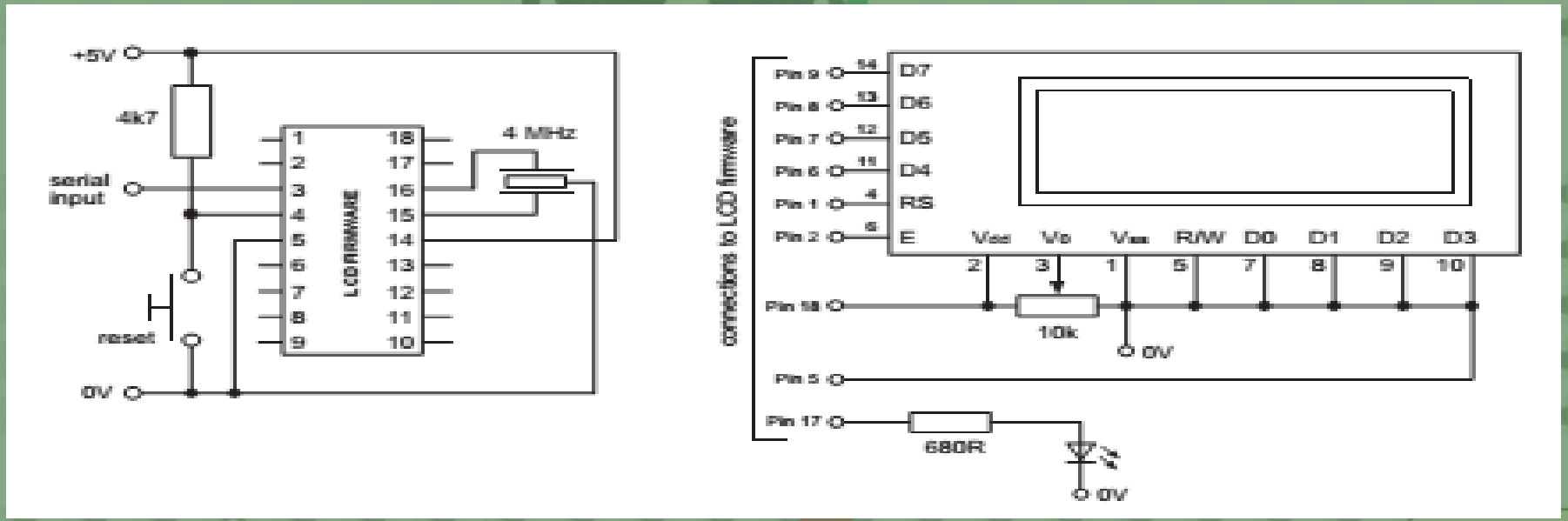
Serial Character LCD Display Driver IC - Block Diagram.



III. Overview of Intefacing Techniques.

Advanced Technique #1:

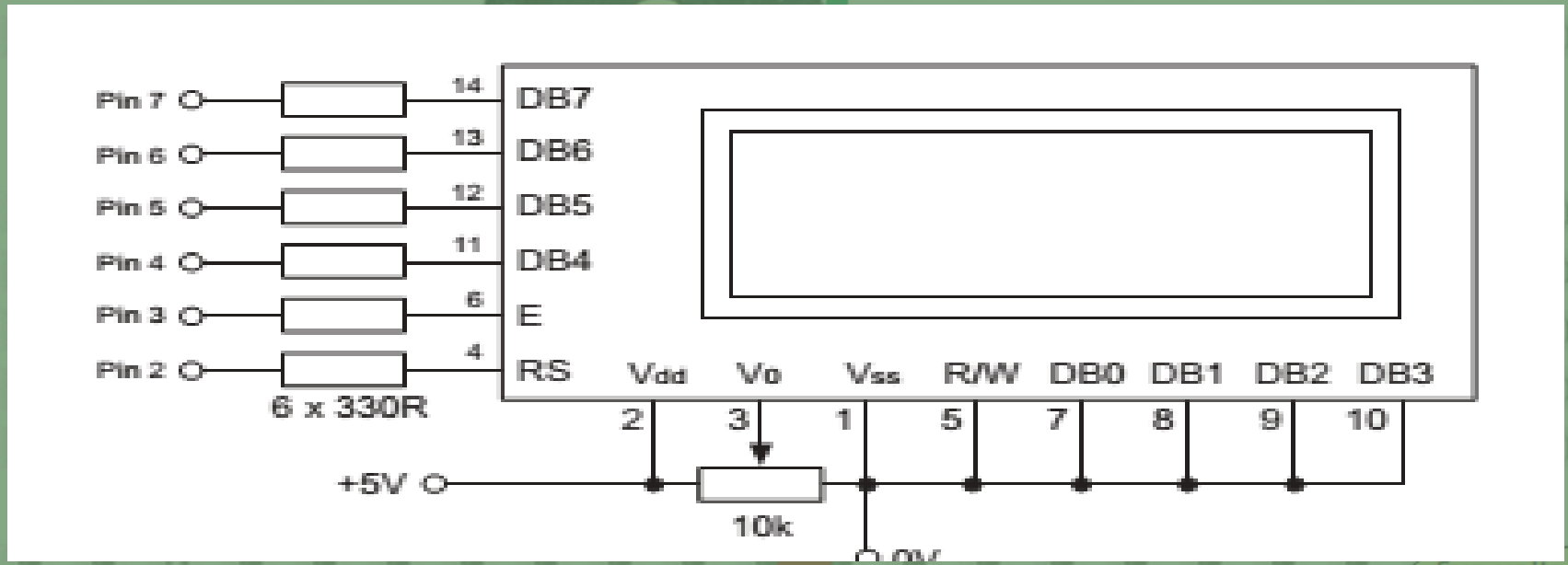
Serial Character LCD Display Driver IC - Schematic Diagram.



III. Overview of Intefacing Techniques.

Advanced Technique #2:

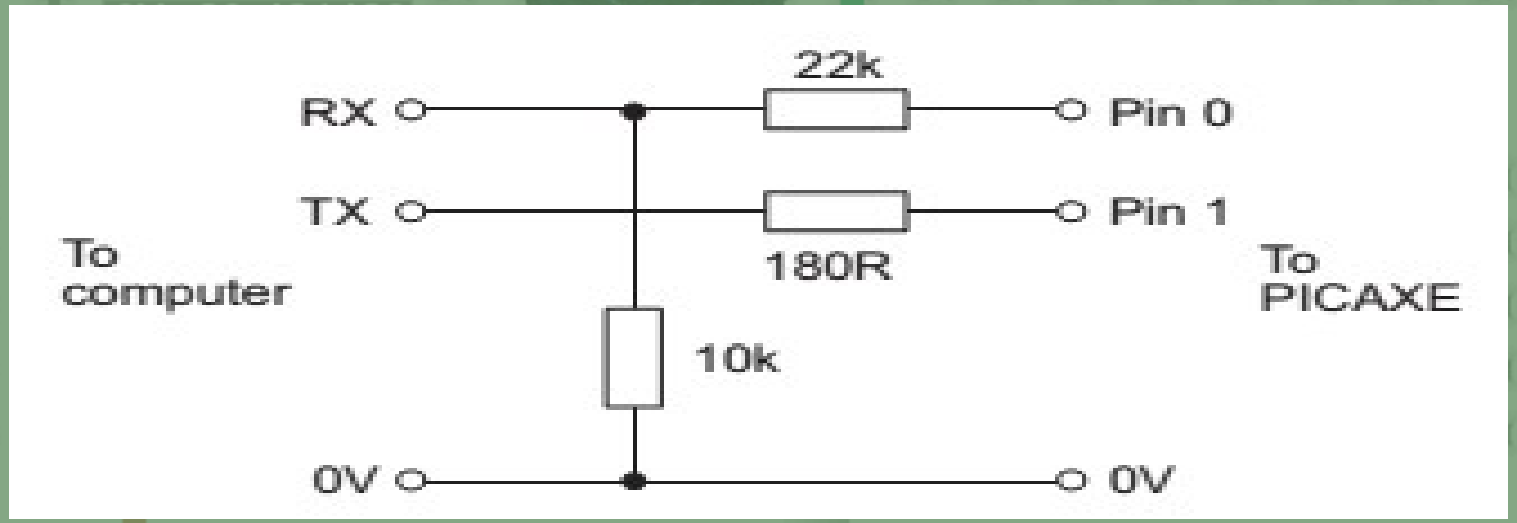
Parallel Character LCD Display Module.



III. Overview of Intefacing Techniques.

Advanced Technique #3:

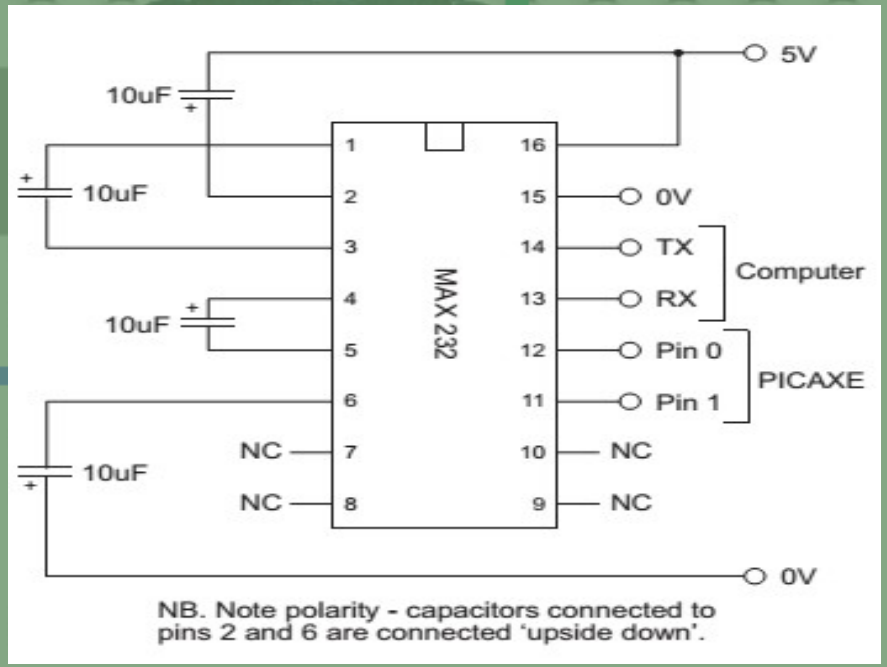
Serial Port (RS232) Interface – Direct.



III. Overview of Intefacing Techniques.

Advanced Technique #4:

Serial Port (RS232) Interface – IC.



NB. Note polarity - capacitors connected to pins 2 and 6 are connected 'upside down'.

III. Overview of Intefacing Techniques.

Advanced Technique #5:

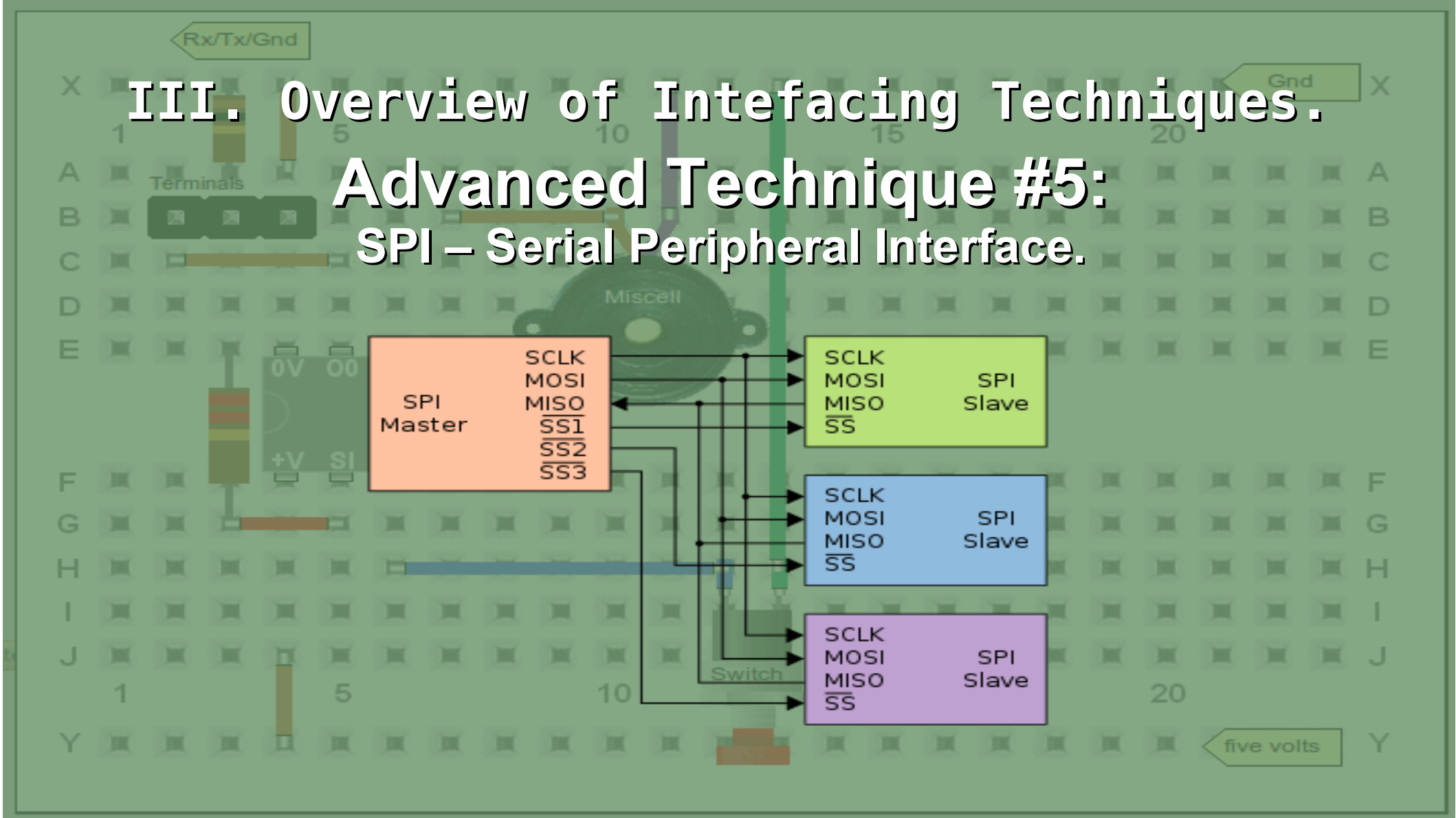
SPI – Serial Peripheral Interface.

- Developed by Motorola: Now Freescale.
- Master-Slave Configuration.
- Synchronous Communicaion: Clock Signal.
- Four Wire Serial Bus: Clock, MOSI, MISO, Select.
- Faster than I2C.
- https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

III. Overview of Intefacing Techniques.

Advanced Technique #5:

SPI – Serial Peripheral Interface.



III. Overview of Intefacing Techniques.

Advanced Technique #6:

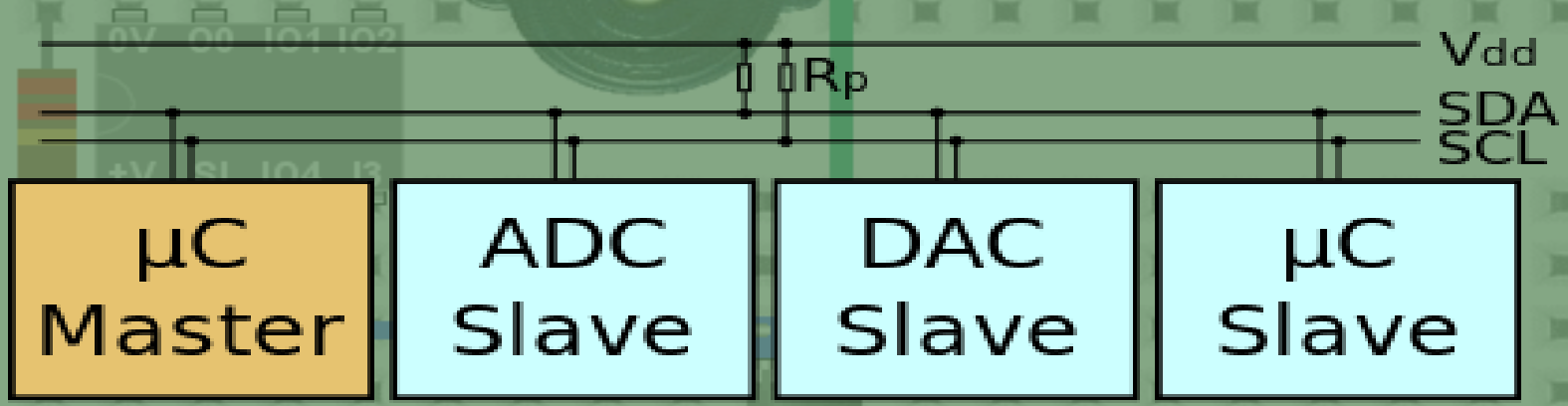
I2C – Inter Integrated Circuit.

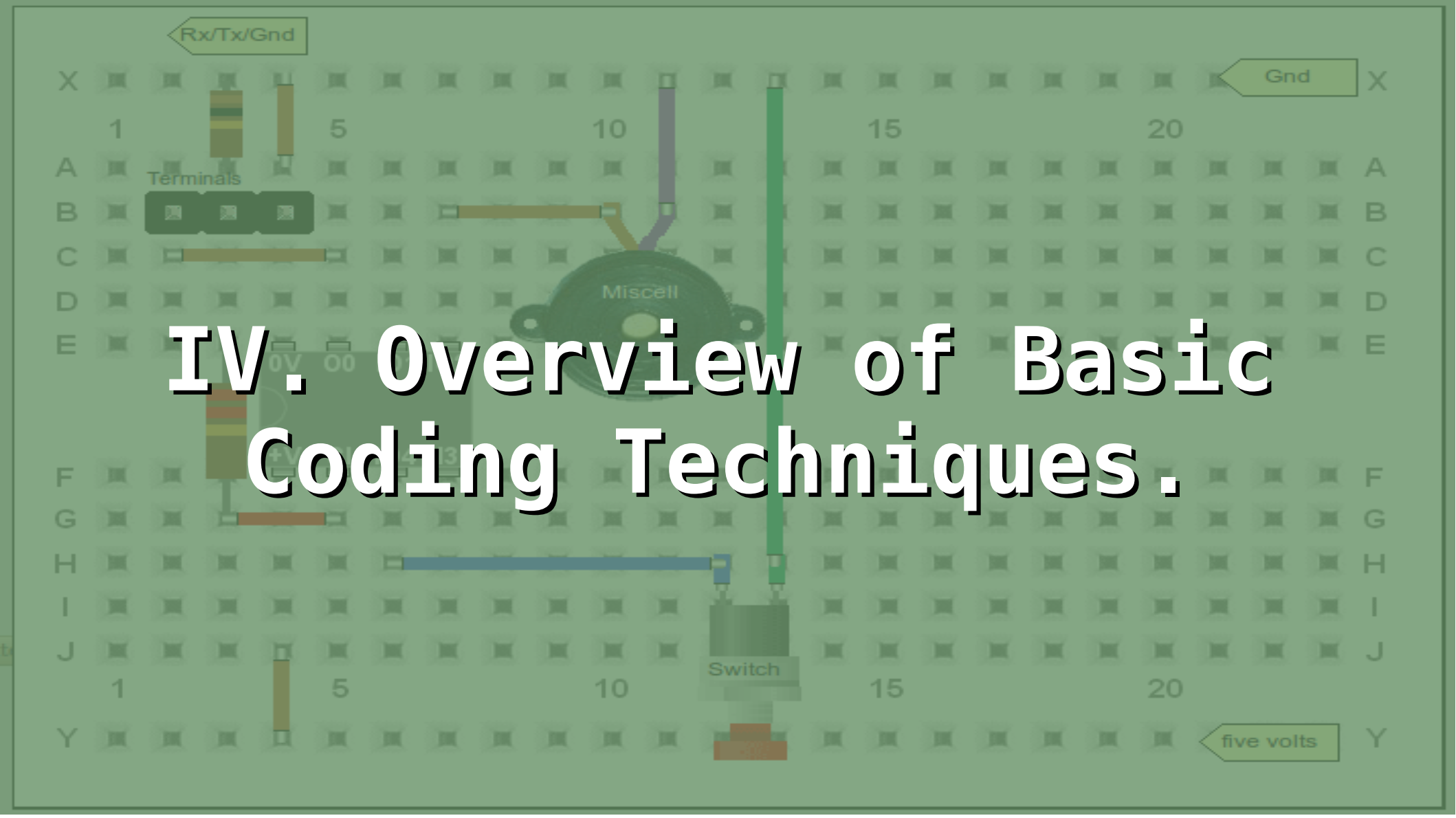
- Developed by Phillips in 1982: Now NXP.
- Master-Slave Configuration.
- Asynchronous Communication: Sync with Data.
- Two Wire Serial Standard: SCK, SDL.
- Slower then SPI but less pins.
- https://en.wikipedia.org/wiki/I%C2%B2C

III. Overview of Intefacing Techniques.

Advanced Technique #6:

I2C – Inter Integrated Circuit.





IV. Overview of Basic Coding Techniques.

IV. Overview of Basic Coding Techniques.

The following are some basic coding techniques for some of the interfaces illustrated earlier.

The following code examples are in PICAXE Basic. The PICAXE is a PIC Microcontroller with a proprietary BASIC interpreter: https://picaxe.com

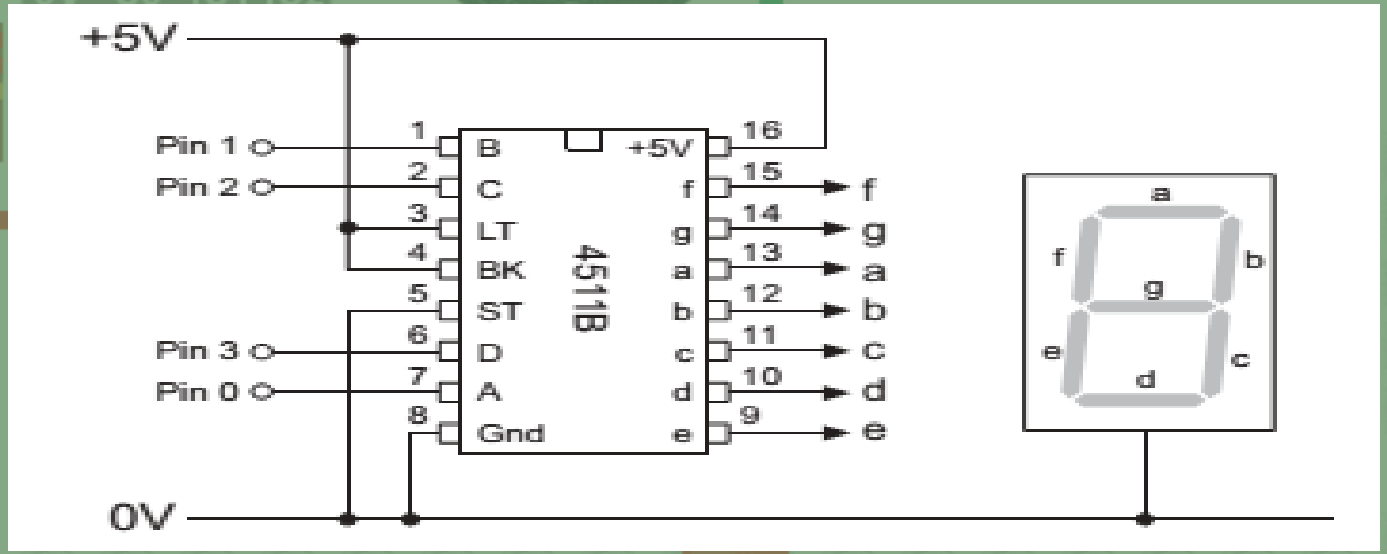
IV. Overview of Basic Coding Techniques.

Coding Technique #1:
Turning LED, Lamp or Relay On and Off.

```
main:
    high B.4
    pause 1000
    low B.4
    pause 1000
    goto main
```

IV. Overview of Basic Coding Techniques.

Coding Technique #2:
Seven Segment LED Interface.



IV. Overview of Basic Coding Techniques.

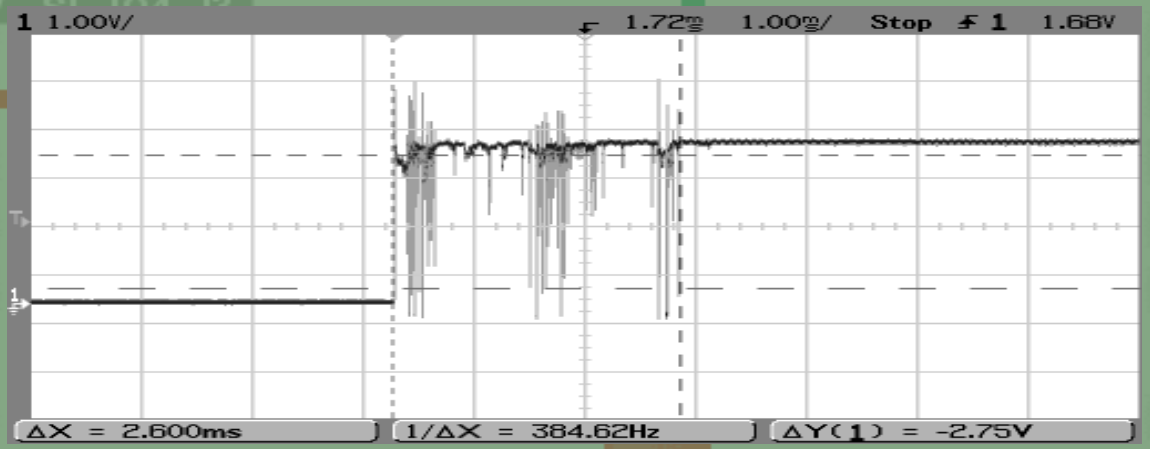
Coding Technique #2:
Seven Segment LED Interface.

```
main:  for b1 = 0 to 9          ' Set up a for...next loop using variable b1
          let pins=b1           ' Output b1 onto the four data lines
         pause 1000             ' Pause 1 second
       next b1                  ' Next
       goto main                ' Loop back to start
```

IV. Overview of Basic Coding Techniques.

Coding Technique #3: Reading a Switch.

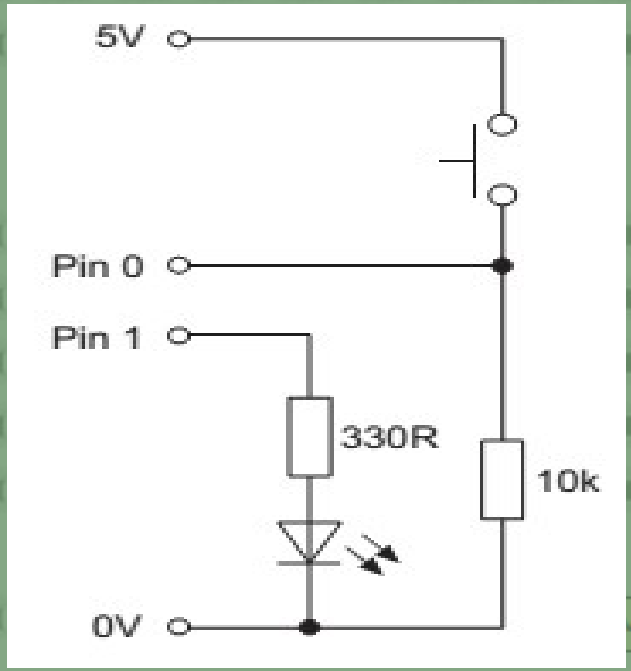
What Happens when you press a switch?



IV. Overview of Basic Coding Techniques.

Coding Technique #3: Reading a Switch.

The next slide will illustate the effects of a switch before and after proper debouncing. The first group of code on the left is without debounce and the second group of code on the right is with debounce.



IV. Overview of Basic Coding Techniques.

Coding Technique #3: Reading a Switch.

```
init:  let b0 = 0

main:  if pin 1 = 1 then add
       goto main

add:   let b0 = b0 + 1
       if b0 < 5 then main
       high 1
       goto main
```

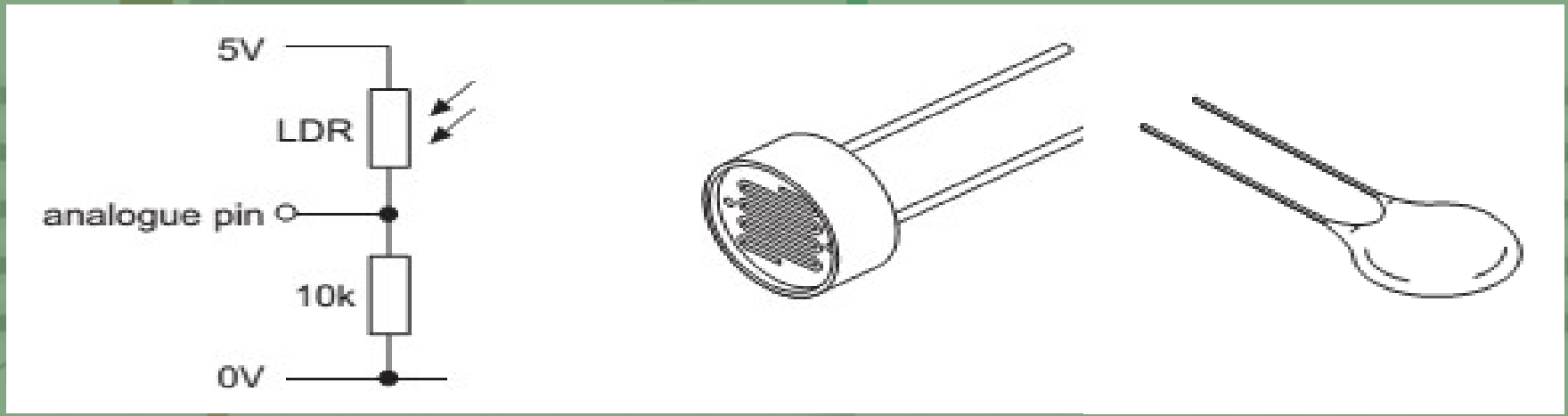
```
init:  let b0 = 0

main:  if pin 1 = 1 then add
       goto main

add:   pause 100     'short delay
       let b0 = b0 + 1
       if b0 < 5 then main
       high 1
       goto main
```

IV. Overview of Basic Coding Techniques.

Coding Technique #4:
Reading a Thermistor or a CdS Cell.



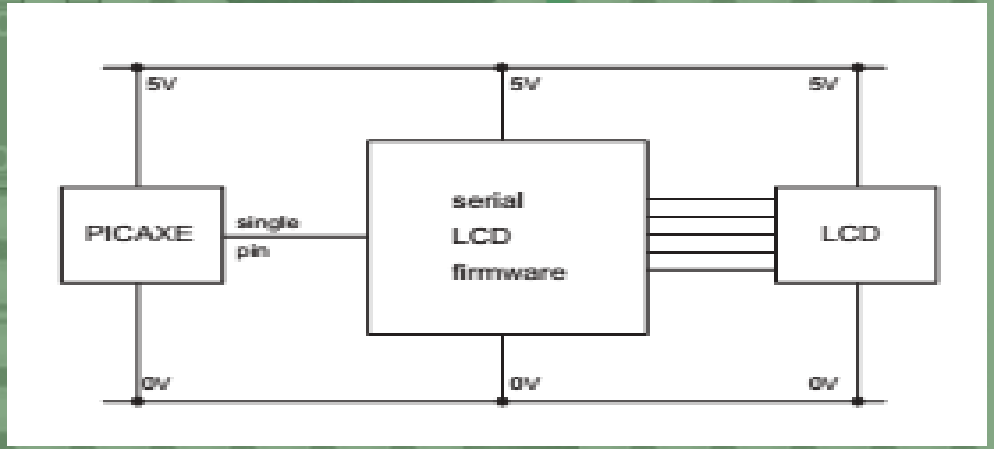
IV. Overview of Basic Coding Techniques.

Coding Technique #4:
Reading a Thermistor or a CdS Cell.

```
main:  readadc 0,b1                    ' read the value
       if b1<50 then light1            ' range 0-50 = 50
       if b1<100 then light2           ' range 50-100 = 50
       if b1<145 then light3           ' range 100-145 = 45
       if b1<175 then light4           ' range 145-175 = 30
       goto main
```

IV. Overview of Basic Coding Techniques.

Coding Technique #5:
Sending Data to a Charcter Serial LCD Display.



IV. Overview of Basic Coding Techniques.

Coding Technique #5:
Sending Data to a Charcter Serial LCD Display.

Main:

```
serout 1,N2400,(“Hello”) ‘ Send the word ‘Hello’
serout 1,N2400,(10,13) ‘ Send the ‘new line’ instructions.
pause 1000 ‘ Wait one second
goto main ‘ Loop back to the start
```

Questions?

Discussion?

Thank you for your attention and participation!!

CONTACT INFORMATION

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